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TECHNIQUES FOR DETERMINING AIRPORT AIRSIDE CAPACITY AND DELAY.(U)

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TECHNIQUES FOR DETERMINING AIRPORT AIRSIDE CAPACITY AND DELAY

DOUGLAS AIRCRAFT COMPANY,
LONG BEACH, CALIFORNIA

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TECHNIQUES FOR DETERMINING AIRPORT AIRSIDE CAPACITY AND DELAY

Final Report
June 1976

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16. Abstract

This report contains procedures for determining the capacity of the airfield and its components and for determining delays to aircraft operating on the airfield. This report is structured to permit the user to choose the method of analysis most suited to the complexity of the user's problem or the level of detail desired.

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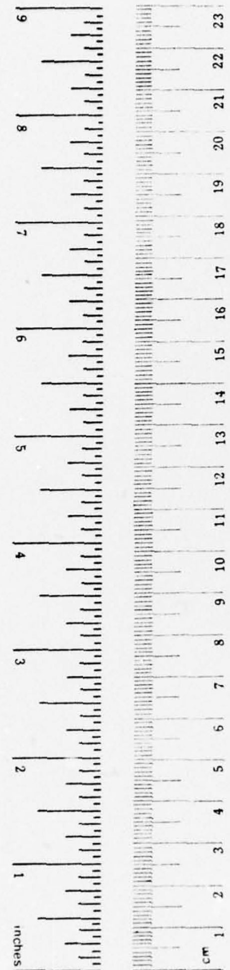
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

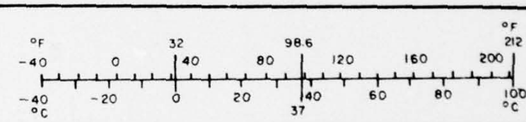
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

This report was prepared for the Federal Aviation Administration's Systems Research and Development Service as part of its broad research program to develop new and improved methods which will provide a basis for determining how best to increase capacity and minimize congestion on the airfield. The report represents the joint efforts of a project team consisting of Douglas Aircraft Company in association with Peat, Marwick, Mitchell & Co. (PMM&Co.); McDonnell Douglas Automation Company (MCAUTO); and American Airlines, Inc. In addition, Professor Robert Horonjeff of the University of California, Berkeley, served as general advisor to the project team.

As part of the project team's coordinated efforts on the overall project, each organization carried out specific project responsibilities, as summarized below.

Organization	Douglas Aircraft Co. McDonnell Douglas Corporation	PMM&Co.	MCAUTO	American Airlines, Inc.
Overall project responsibility	Prime contractor; overall technical direction and project management; data collection support; computerized section of handbook	Capacity and delay model development; handbook development; management of data collection and analysis; software review, modification, and development; training	Interactive graphics system and real-time simulator feasibility studies; delay model ATC algorithm; model software development; data processing; software documentation; training	General advisory, overall project

The project team appreciates the assistance they received from the Federal Aviation Administration's Airports Service, and other participating branches of FAA, as well as the airlines, various airport sponsors, and other interested organizations who contributed to the efforts of this project.

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CHAPTER 1. INTRODUCTION

1. PURPOSE OF REPORT. The purpose of this report is to present procedures for determining the capacity of the airport airside and for determining delays to aircraft operating on the airside. The term airside refers to the airfield and its components (i.e., runways, taxiways, and apron-gate areas).

The procedures in this report are based on field observations at 18 high-activity airports in the United States, both air carrier and general aviation. Background and detailed assumptions used in the development of the report are presented in three companion reports.[1,2,3a]

2. BACKGROUND LEADING TO THE DEVELOPMENT OF THIS REPORT. Predecessor documents for estimating capacity and delay include, "Airport Capacity," June 1963; FAA Advisory Circular 150/5060-1A, "Airport Capacity Criteria Used in Preparing the National Airport Plan," dated July 8, 1968; FAA Advisory Circular 150/5060-3A, "Airport Capacity Criteria Used in Long Range Planning," dated December 24, 1969; and "Airport Capacity Handbook," second edition, June 1969.

These documents are based on analytical models developed in the early 1960s and the inputs used for the development of charts in these documents are based on observations at selected airports made at about the same time. Since that time, widebody aircraft have been placed in service, requiring the revision of aircraft separation rules to account for the strong wake vortices generated by these aircraft.

In addition, the predecessor documents are primarily confined to determining capacity and delay on the runways, whereas this report also covers capacity and delay on taxiways crossing active runways and apron-gate areas where airline aircraft park.

---

a. For numbered references, see Paragraph 11 on page 17.

3. SCOPE OF REPORT. The airfield planning process may include several stages from preliminary assessment to detailed evaluation of airfield performance. This report, therefore, is structured so that the user can choose the method of analysis best suited to his needs.

The report contains four chapters and five appendixes.

a. Chapter 1. Introduction. Chapter 1 outlines the purpose and scope of the report; defines the airfield and its components; explains the terms used; and suggests uses and limitations of the report in airport planning and development.

b. Chapter 2. Analysis of Capacity and Delay. Chapter 2 describes a series of procedures using charts for estimating capacity for a wide range of airfield components (i.e., runways, taxiways, and apron-gate areas). The chapter also contains procedures for determining hourly, daily, and annual delays to aircraft on these components.

c. Chapter 3. Computerized Techniques to Determine Hourly Capacity of Runways and Annual Delay to Aircraft. Chapter 3 presents computerized techniques for determining the hourly capacity of the runway component and annual delay to aircraft on the runway component.

d. Chapter 4. Airfield Evaluation by Computer Models. If a more detailed evaluation of capacity and delay is required than that possible from either Chapters 2 or 3, the evaluation can be made by computer models. Chapter 4 briefly summarizes the scope of FAA simulation and analytical models used to compute the capacity and delay values in this report and presents a summary of model inputs and outputs.

e. Appendix 1 - Preliminary Analysis of Capacity and Delay. This appendix describes a simplified procedure for estimating capacity and delay for a number of typical runway configurations.

In general, the use of Chapters 2 or 3 is encouraged rather than Appendix 1. Appendix 1 was prepared to provide a simple procedure for estimating runway capacity and annual delay in preliminary planning when a very approximate estimate of capacity or delay is all that is needed.

f. Appendix 2 - Effect of Ceiling and Visibility on Runway Capacity. This appendix presents a procedure to estimate the hourly capacity of a single runway and certain two parallel and intersecting runways when ceiling and visibility conditions are extremely poor.

g. Appendix 3 - Effect of Navigational Aids on Runway Capacity. Appendix 3 presents a procedure to estimate the hourly capacity of a single runway and certain two parallel and intersecting runways in IFR conditions without a radar environment and/or an ILS.

h. Appendix 4 - Evaluation of Runways Without Minimum Exit Taxiways. This appendix presents a simple procedure for determining the hourly capacity for single runway general aviation airports without the minimum taxiways assumed in Chapters 2 and 3.

i. Appendix 5 - Runway Restricted Use. The procedures presented in Chapters 2 and 3 are based on the assumption that all runways can be used by a majority of the aircraft using an airport. The hourly capacity of parallel runways where some classes of aircraft are restricted from using a particular runway may be determined using Appendix 5.

4. THE AIRFIELD AND ITS COMPONENTS

a. Airfield. The airfield is defined as a system of components (i.e., runways, taxiways, and apron-gate areas) on which aircraft operate. A simplified diagram of the airfield and its relationship to the adjacent airspace is shown in Figure 1-1.[a]

---

a. Both figures used in this chapter (Figure 1-1 and Figure 1-2) are located at the end of this chapter.

b. Runway Component. Air traffic control procedures (including those reflecting the effects of wake vortices) are major factors that influence runway component capacity and delay; therefore, the runway component encompasses the common approach and departure paths to and from the runways.

c. Taxiway Component. The capacity of the taxiway component usually is much greater than the capacities of the runway or apron-gate components, with one exception--taxiways crossing an active runway. Thus, this report only covers capacity and delay on a taxiway crossing an active runway.

d. Apron-Gate Area Component. Because general aviation aircraft do not operate on a fixed schedule, general aviation parking times in the apron area fluctuate widely. Therefore, this report covers only the capacity and delay on an air carrier aircraft parking apron. For simplicity, the apron-gate area component is hereinafter referred to as the "gate component."

e. Component Independence. For determining capacity and delay, the operations on the runways, taxiways, and gates at most airports can be considered independent of each other and analyzed separately.[1,3] For planning purposes, it is sufficiently accurate to assume that the capacity of the runways is not affected by operations on either the gates or the taxiways.

Because operations on one airfield component generally do not affect the capacity of another component, the capacity of the entire airfield is governed by the capacity of one of the three components (i.e., the "weakest link" or as hereinafter sometimes referred to--the "constraining component"). Procedures for identifying the constraining component are presented in Paragraph 25 on page 40. In addition, because operations on one component have little influence on the delay to aircraft on another component, the total delay to aircraft on the entire airfield can be estimated by adding the delay to aircraft on each individual airfield component.

5. DEFINITION OF TERMS. The principal terms used in this report are as follows:

a. <u>Hourly Capacity of Runways</u>. The hourly capacity of the runway component is defined as the maximum number of aircraft operations (i.e., arrivals, departures) that can take place on the runway component in an hour. The maximum number of aircraft operations depends on a number of conditions including, but not limited to, the following:

(1) <u>Ceiling and Visibility</u>. For purposes of this report the terms "VFR" and "IFR" are used as measures relating to ceiling and visibility.

In the airspace adjacent to an airport with a control zone, VFR (visual flight rules) conditions occur when the ceiling is at least 1,000 feet and the visibility is at least three statute miles. During VFR conditions, pilots space themselves according to what they consider safe except where aircraft are sequenced by radar such as in a Terminal Control Area (TCA) or where Stage III radar sequencing service[a] is provided.

IFR (instrument flight rules) conditions occur when the ceiling is less than 1,000 feet and/or visibility is less than three statute miles. During IFR conditions, the air traffic control system assumes responsibility for providing safe separation between aircraft and specifies the minimum spacing between all aircraft.

In IFR conditions, the occurrence of certain poor ceiling and visibility conditions (e.g., ceiling is less than 500 feet and/or visibility is less than one statute mile) may affect runway capacity. Procedures for the determination of hourly capacity of runways during these poor conditions (referred to herein as "PVC") are contained in Chapter 3 and in Appendix 2. In addition, in this report it is assumed that operations in IFR conditions are conducted in a radar environment and that arrivals operate on at least one runway equipped with an instrument

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a. For information on the service provided see Reference 4.

landing system (ILS), except in Appendix 3. A procedure is presented in Appendix 3 for determining hourly capacities in IFR conditions without radar and/or an ILS.

(2) Runway Use. Runway use is defined in terms of the number, location, and orientation of active runways (i.e., runways in use at a particular time) and involves the directions and kinds of operations using each runway. The definition of runway use is further illustrated in the example in Paragraph 21.a.(2) on page 22.

(3) Aircraft Mix. Aircraft mix is defined in terms of four aircraft classes: A, B, C, and D.

Class A includes small single-engine aircraft (i.e., aircraft weighing 12,500 pounds[a] or less). Class B includes small twin-engine aircraft (i.e., aircraft weighing 12,500 pounds[a] or less and Lear jets); Class C includes large aircraft (i.e., aircraft of more than 12,500 pounds[a] and up to 300,000 pounds[a]); and Class D includes heavy aircraft (i.e., aircraft capable of weights of 300,000 pounds[a] or more).

A list of typical aircraft in each class is presented in Figure 1-2.

(4) Percent Arrivals. The percent of all aircraft operations that are arrivals has an important influence on the hourly capacity of runways. For example, a runway used exclusively for arrivals will have a different capacity from a runway used exclusively for departures or for mixed operations (i.e., arrivals and departures) A procedure for computing the percent arrivals is presented in Paragraph 21.a.(4) on page 23.

(5) Percent Touch-and-Go. A touch-and-go operation refers to an aircraft landing and then immediately taking off (without making a full stop). Because a touch-and-go is both an arrival and a departure, it is counted as two aircraft operations. A procedure for computing percent touch-and-go is presented in Paragraph 21.a.(4) on page 23.

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a. Maximum certificated takeoff weight.

In general, significant numbers of touch-and-go operations do not occur at airports used predominantly by air carrier aircraft; therefore, the influence of touch-and-go operations in planning such airports may not be important. However, touch-and-go operations are important at airports used almost entirely by general aviation aircraft.

(6) Exit Taxiway Location. Runway occupancy time can affect the hourly capacity of runways. Because the location of exit taxiways affects runway occupancy times, exit taxiway location can be important in determining runway capacity. The location of an exit taxiway is measured in feet from the arrival threshold of the runway.

In Chapters 2 and 3, it is assumed that as a minimum, an exit taxiway is located at both ends of each runway; however, the user must identify the locations of other exit taxiways. A procedure for determining runway capacity at general aviation airports where exit taxiways do not exist at both ends of each runway is presented in Appendix 4.

(7) Other Operating Conditions. In Chapter 3, certain additional operating conditions also must be specified (e.g., wet or dry runway). For purposes of this report, all other operating conditions affecting runway capacity (e.g., pilot performance and air traffic control procedures) are assumed to be constant.

It is important to point out that the definition of hourly capacity of runways in this report differs from the definition in predecessor documents listed in Paragraph 2 inasmuch as the definition of capacity herein contains no assumptions regarding "acceptable" levels of delay to aircraft. In predecessor documents, levels of average delay for arrival and departure aircraft are specified for different mixes of aircraft and weather (e.g., four minutes delay for aircraft in IFR); the aircraft demand (aircraft operations rate) corresponding to these predetermined levels of delay was defined as "practical hourly capacity."

Capacity as defined in this report expresses the maximum physical capability of an airfield or any one of its components (i.e., a saturation capacity). It is a maximum aircraft operations rate for a set of specified conditions and is independent of the level of average aircraft delay (actually, when traffic volumes reach capacity levels in an hour, delay to aircraft may average from 2 to 10 minutes). Consequently, for the same specific conditions, the capacity values in this report may tend to be slightly higher than in the predecessor handbook.

There are several reasons for choosing this definition of capacity. First, there is lack of agreement on what are "acceptable" levels of delay applicable to all airports and their airfield components. Because constraints differ from airport to airport, the amount of "acceptable" delay differs from airport to airport.

Second, because the pattern (i.e., fluctuations) of demand within an hour can vary widely, there may be large variations in average delay for the same level of hourly aircraft demand. Thus, for the same physical facility (e.g., a runway), the "practical hourly capacity" would be different each time the pattern of demand changed.

This report provides the user with comprehensive procedures for determining capacity and delay to an aircraft for a wide range of conditions, and includes the flexibility of determining the demand (aircraft operations rate) for any desired level of service (i.e., level of average delay). An example of such a calculation is shown on page 53 of Chapter 2.

b. Hourly Capacity of Taxiway Crossing an Active Runway. The hourly capacity of a taxiway crossing an active runway is defined as the maximum number of aircraft operations (i.e., crossing movements) that can take place on a taxiway crossing an active runway in an hour. The maximum number of aircraft operations depends on a number of conditions including, but not limited to:

(1) Intersecting Taxiway Location. The location of a taxiway crossing an active runway is measured in feet from the threshold of the active runway.

(2) Runway Operations Rate. Runway operations rate is expressed in terms of the number of aircraft operations per hour (i.e., arrivals, departures, touch-and-go) on the active runway.

(3) Aircraft Mix Using Runway. Information on the aircraft mix using the active runway is required for the determination of taxiway capacity.

(4) Other Operating Conditions. For purposes of this report, all other operating conditions (e.g., width of active runway, visibility, pilot and controller performance) are assumed to be constant.

c. Hourly Capacity of Gates. The hourly capacity of gates is defined as the maximum number of aircraft operations that can take place on the gate component in an hour. The maximum number of operations (i.e., arrivals to the gates, departures from the gates) depends on a number of conditions including, but not limited to, the following:

(1) Gate. For this report, a gate is defined as an aircraft parking position adjacent to a terminal building used by a single aircraft for loading and unloading passengers, cargo, and mail. If an aircraft parking position is used regularly by two (or more) aircraft at the same time (i.e., "double parking"), two gates (or more as appropriate) are defined to exist.

(2) Number of Gate Groups. For this report, those gates used by one airline are referred to as a gate group. Occasionally, a gate group may accommodate more than one airline.

(3) Numbers and Types of Gates in Each Gate Group. Gate types are expressed in terms of the sizes of aircraft they can serve. In this report, it is assumed that all gates are one of two types--Type 1, those gates that can be used by widebody aircraft (e.g., B-747, DC-10, L-1011); and Type 2, those gates that cannot be used by widebody aircraft. In addition, it is assumed that non-widebody aircraft may also use Type 1 gates.

(4) Gate Mix. The gate mix is the percent of non-widebody aircraft (e.g., all aircraft except DC-10, L-1011, B-747, etc.) using each gate group.

(5) Gate Occupancy Time. Gate occupancy time is the time spent by an aircraft at a gate. The time varies depending on the size of the aircraft, and whether the scheduled flight of the aircraft originates or terminates at the airport or whether the aircraft is making an intermediate stop at the airport.

(6) Other Operating Conditions. For this report, all other operating conditions are assumed to be constant.

One operating condition that can significantly influence the hourly capacity of gates is the scheduling practices of the airline(s) using the gates. For this reason, the results of a gate capacity analysis should be reviewed with the appropriate airline if gate capacity is considered critical.

d. Hourly Capacity of Airfield. The hourly capacity of the airfield is defined as the maximum number of aircraft operations that can take place on the airfield in an hour. The maximum number of operations depends on the conditions indicated previously for each of the airfield components. The hourly capacity of the airfield is governed by the capacity of its "constraining component," as described in Paragraph 25, on page 40.

e. Annual Service Volume. Annual service volume is a level of annual aircraft operations that may be used as a reference in preliminary planning.

As annual aircraft operations approach annual service volume, average delay to each aircraft throughout the year may increase rapidly with relatively small increases in aircraft operations, thereby causing levels of service on the airfield to deteriorate.

When annual aircraft operations on the airfield are equal to annual service volume, average delay to each aircraft throughout the year is on the order of one to four minutes. A more precise estimate of actual

average delay to aircraft at a particular airport can be obtained using the procedures described in Paragraph 29, on page 71, or Paragraph 33, on page 154.

If the number of annual operations exceeds annual service volume, moderate or severe congestion may occur, similar to that experienced at several of the airports surveyed during the development of this report (including Chicago O'Hare International Airport, LaGuardia Airport, and William B. Hartsfield Atlanta International Airport).

For analyses of airfield improvements, aircraft delays also can be important at levels of annual aircraft operations less than annual service volume. Therefore, delays to aircraft should also be considered in planning and evaluating airfield improvements at levels of annual operations less than annual service volume. In some instances, when annual demand is expected to approach one-half of annual service volume within the planning horizon, nominal construction costs of airfield improvements may be balanced by savings in aircraft delay costs.

f. Demand. The demand is the number of aircraft that desire to use the airfield (or one of its three components) in a given interval of time (e.g., one hour).

g. Delay. Delay to aircraft is defined as the difference between the actual time it takes an aircraft to operate on an airfield (or component) and the time it would take the aircraft to operate without interference from other aircraft on the airfield (or component) under the conditions described previously in Paragraphs 5.a, 5.b, and 5.c. Delay is expressed in minutes.

h. Hourly Delay to Aircraft. Hourly delay is the total delay incurred by all aircraft on the airfield (or component) during a period of one hour. For determining hourly delay to aircraft on an airfield, information is needed concerning the delay to aircraft on the runways, taxiways crossing an active runway, and gates. The sum of the delay on the components represents the delay on the entire airfield.

i. Daily Delay to Aircraft. Daily delay is the total delay incurred by all aircraft on the airfield (or component) during a day. Daily delay on the airfield is the sum of the daily delays on the runways, taxiways crossing an active runway, and gates.

j. Annual Delay to Aircraft. Annual delay is the total delay incurred by all aircraft on the airfield (or component) during a year. Annual delay on the airfield is the sum of the annual delays on the runways and gates.

6. RELATIONSHIP BETWEEN CAPACITY, DEMAND, AND DELAY. As stated previously, hourly capacity is defined in this report as the maximum number of aircraft operations that the airfield or one of its components can accommodate for specified operating conditions (e.g., aircraft mix). It expresses the ultimate physical capability of an airfield and its components and is independent of both the magnitude and fluctuation of demand and the level of delay to aircraft. In this context, demand is independent of capacity and the level of delay to aircraft.

Delay, on the other hand, is dependent on capacity and the magnitude and fluctuation in demand. For example, delays can occur even when the demand averaged over one hour is less than the hourly capacity. Such delays occur because demand fluctuates within an hour so that during some small intervals of time (i.e., less than one hour), demand is greater than capacity.

If the magnitude and fluctuations in demand are fixed, the only way to reduce delay is to increase capacity. On the other hand, if demand can be manipulated to produce a more uniform pattern of demand (i.e., reduce peaks in demand), then delay can be reduced without increasing capacity. Thus, estimating capacity is an integral step in determining delay to aircraft.

Numerical examples of this important relationship between capacity, demand, and delay are presented in Chapter 2.

7. <u>THE USE OF CAPACITY AND DELAY IN AIRFIELD PLANNING</u>. Capacity is an important index of performance of an airfield but should not be used as the sole criterion for determining if additional airfield improvements are required.

In preliminary planning, several alternative airfield improvements are usually considered. Capacity is a useful criterion for initial screening of the alternatives and for selecting airfield improvements for further analysis.

When demand approaches capacity, delays to aircraft build up very rapidly. Because of the congestion that may be associated with rapid buildups of delay, users of this report should exercise caution when planning for airports where demands are expected to approach capacity levels for more than very short periods of time. Also, because of their economic importance, estimating the magnitude of delays usually is much more important in determining the justification and requirement for airfield improvements than a determination of capacity.

In summary, the operational and economic implications of delay to aircraft generally dictate that delay to aircraft be included in airfield planning studies considerably before demand is expected to reach capacity levels.

8. <u>AIRFIELD PLANNING AND DEVELOPMENT</u>. One principal objective of the report is to provide the user with guidance in determining an efficient means to increase capacities and reduce delays. Since each airport site is unique (e.g., existing facilities, topography, noise sensitive areas), the procedures in this report are structured to help the user identify ways to improve the airport under study. For example:

a. <u>Exit Taxiways</u>. One airfield improvement frequently considered to increase capacity and reduce delays is the construction of additional exit taxiways. The studies leading to the development of this report show that the location of exit taxiways can have an important effect on runway capacity, particularly in VFR conditions.

Another important conclusion is that the type of exit taxiway (i.e., perpendicular or angled) has a relatively small effect on runway capacity under existing air traffic control rules and aircraft operating procedures. However, angled exits may be preferred for other operational reasons.

Consequently, the procedures in Chapters 2 and 3 account for the effect on runway capacity of exit taxiway location. In Chapter 2, the sensitivity of runway capacity in relation to exit taxiway location is evident from the capacity charts for each runway use.

Another important taxiway analysis concerns the staged development of a simple airport (i.e., a minimum facility consisting of a runway without a parallel taxiway) into a basic airport layout (i.e., a runway with a parallel taxiway and one exit taxiway in between). The procedures in Chapters 2 and 3 assume that, at a minimum, an exit taxiway is located at both ends of each runway; therefore, a special procedure for evaluating runways without exit taxiways at both ends of the runways is presented in Appendix 4.

b. <u>Restrictions on the Use of Runways</u>. Another application of the report may involve analysis of capacity and delay at an airfield when the use of the runways is restricted by environmental or physical constraints (e.g., preferential use of runways for noise abatement, or limited runway length or strength).

In Chapters 2 and 3, a number of runway uses are presented to enable the user to select the specific runway use in effect at his airport.

Another type of restriction to the operations on an airport may be a limitation on the use of certain runways by large aircraft because of existing strength or length.

A method for determining capacities of runways when large aircraft are so restricted (referred to as "runway restricted use") is contained in Appendix 5.

c. <u>Wake Vortices</u>. Extensive flight tests undertaken by FAA and NASA, demonstrated the necessity for preventing aircraft from flying too close to large or heavy aircraft. To avoid hazardous conditions caused by wake vortices, the FAA has specified minimum separations between various sizes of aircraft.

These separations generally prevail regardless of weather conditions and are greater than the minimum separation required in IFR conditions if there is no hazard from wake vortices.

Knowledge of the specifics of the separation criteria is not required for users of this report since the criteria are incorporated in the procedures in Chapters 2 and 3. However, an understanding of the impact of these separation criteria on capacity may be determined by examining capacity estimates for different runway uses.

For example, one sensitive criterion relates to the spacing (lateral separation) between parallel runways used by a significant volume of heavy aircraft. When the runway spacing is less than 2,500 feet, a minimum separation distance is required behind a heavy jet aircraft on one runway and an aircraft on the other runway. This minimum separation is not required if the runway spacing is greater than 2,500 feet. Therefore, wake vortices (in relation to runway spacing) may be important in a particular planning study.

9. CAUTIONS IN THE USE OF THIS REPORT. The material contained in this report is primarily intended for airport planning. The values of capacity and delay obtained from the report cannot and should not be construed as precise values for a particular airport. Rather, the capacity and delay values reflect operations at a wide variety of U.S. airports.

a. Detailed Investigations. In the event a detailed airfield evaluation is required beyond that required in most airport planning studies, the capacity and delay models described in Chapter 4 should be used. Similarly, analyses of complex, high-activity airfields may warrant or require the use of these models, particularly if analyses are critical in determining the justification of costly or environmentally sensitive improvements, or if the analyses involve investigating possible changes in operating procedures at such airports.

In addition to delays estimated using Chapters 2 or 3, delays on the airfield due to (1) lack of capacity in the airspace; (2) maintenance and construction projects; (3) transition from one runway use to another; and (4) saturation or closure of a destination airport can be evaluated using the simulation model described in Chapter 4, provided that model inputs are adjusted to reflect such conditions. For those periods of time when the airport is closed due to ceiling and/or visibility being below operating minima, it may be appropriate to perform separate analyses to determine (1) the delays to aircraft due to aircraft holding while the airport is closed, (2) the delays due to aircraft being diverted to other airports, and (3) the number of flight cancellations and diversions.

b. Underlying Assumptions. In developing general planning procedures for the report, a number of assumptions were made.[1,2,3] These assumptions were based on a large number of field observations and are representative of typical operations at high-activity airports in the United States, both general aviation and air carrier. Users of these techniques are encouraged to develop an understanding of these underlying assumptions so that if specific circumstances at a particular airport vary from assumptions herein, the user can account for the significance of such variance.

c. Consideration of Other Factors. Although information on airfield capacity and delay is clearly important for justifying airfield improvements, other factors (e.g., environmental impact, financial implications) may in the final analysis be of equal, or possibly greater importance. Although these other factors must be considered before final decisions are made on airport planning and improvements, they are not treated in this report.

10. CANCELLATION. This report supersedes the Letter Report, "Use of Runway Capacity and Delay Models: Performance and Assessment Techniques," February 1976, in its entirety.

11. REFERENCES.

1. Procedures for Determination of Airport Capacity, FAA-RD-73-111, Volumes I and II, April 1973, Interim Report, Phase 1.

2. Technical Report on Airport Capacity and Delay Studies, FAA-RD-76-153, June 1976, Final Report, Phase 2.

3. Model Users Manual for Airport Capacity and Delay Models, FAA-RD-76-128, 1975.

4. Airmans' Information Manual, Part 1, February 1976, U.S. Department of Transportation.

5. Support Documentation for Technical Report on Airport Capacity and Delay Studies, FAA-RD-76-162, June 1976, Final Report.

12.-19. RESERVED.

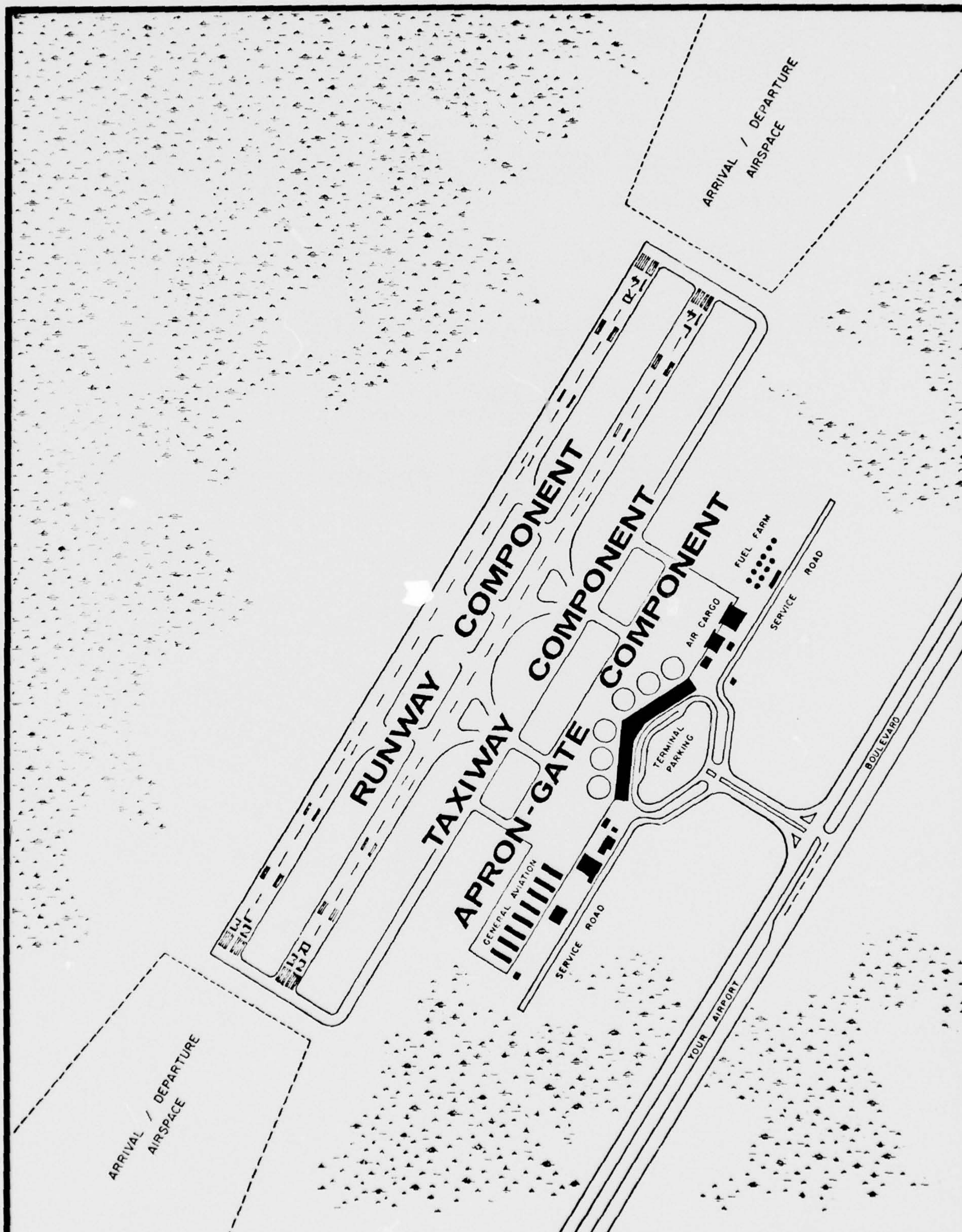

FIGURE 1–1 THE AIRFIELD AND ITS COMPONENTS

Aircraft Classification	Types of Aircraft[a]
Class A	Small single-engine aircraft weighing 12,500 lb[b] or less (e.g., PA18, PA23, C180, C207)
Class B	Small twin-engine aircraft weighing 12,500 lb[b] or less and Lear jets (e.g., PA31, BE55, BE80, BE99, C310, C402, LR25)
Class C	Large aircraft weighing more than 12,500 lb[b] and up to 300,000 lb[b] (e.g., CV34; CV58; CV88; CV99; DC4; DC6; DC7; L188; L49; DC8-10, 20 series; DC9; B737; B727; B720; B707-120; BA11; S210)
Class D	Heavy aircraft[c] weighing more than 300,000 lb (e.g., L1011; DC8-30, 40, 50, 60 series; DC10; B707-300 series; B747; VC10; A300; Concorde; IL62)

a. For aircraft type designators, see FAA Handbook No. 7340.1E with changes.
b. Weights refer to maximum certificated takeoff weight.
c. Heavy aircraft are capable of takeoff weights of 300,000 lb or more whether or not they are operating at this weight during a particular phase of flight. (Reference FAA Handbook 7110.65 with changes.)

FIGURE 1–2 AIRCRAFT CLASSIFICATION

CHAPTER 2. ANALYSIS OF CAPACITY AND DELAY

20. GENERAL. This chapter describes procedures, using charts, for estimating capacity and delay for a wide range of airfield configurations. These procedures can be used to obtain the following information:

Hourly capacity of runway(s)

Hourly capacity of a taxiway crossing an active runway

Hourly capacity of gates

Hourly capacity of an airfield

Annual service volume of runways

Hourly delay to aircraft on runways, taxiways, gates, and airfield

Daily delay to aircraft on runways, taxiways, gates, and airfield

Annual delay to aircraft on runways, gates, and airfield

21. INFORMATION AND DEFINITIONS FOR ANALYSIS OF CAPACITY AND DELAY. Input required for the computation of capacity and delay is shown in Figure 2-1.[a] Each item is summarized briefly in the following paragraphs.

a. Hourly Capacity of Runway. The following information is required for estimating the hourly capacity of runways:

(1) Ceiling and Visibility. For purposes of this chapter, ceiling and visibility conditions are classified as either VFR (visual flight rules) or IFR (instrument flight rules) in accordance with the definitions in Paragraph 5.a.(1) on page 5. Sources of information on the occurrence of ceiling and visibility conditions at a particular airport include the appropriate offices of the National Weather Service and the Flight Service Station, as well as the National Climatic Center in Asheville, North Carolina.

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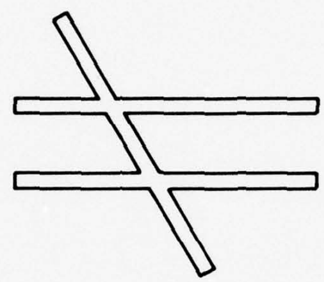
a. All figures used in this chapter (Figures 2-1 through 2-102) are located at the end of this chapter.

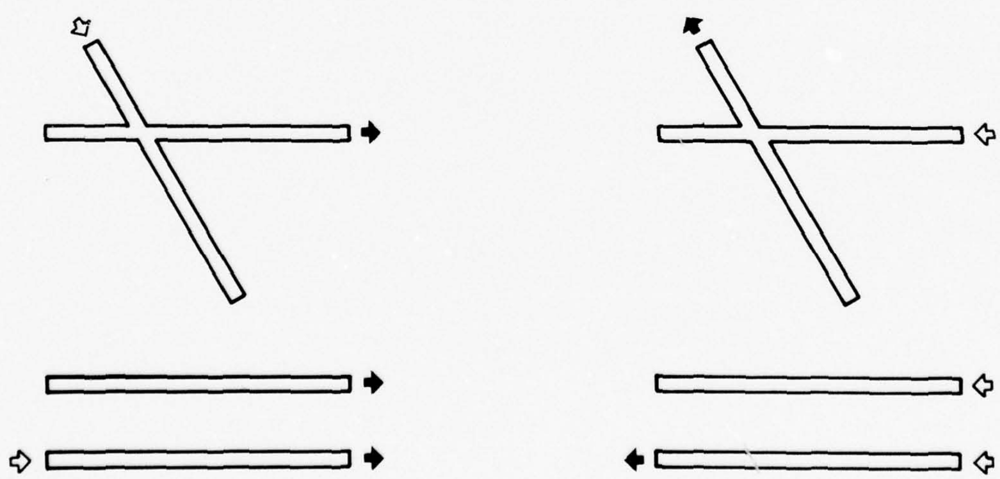
(2) <u>Runway Use</u>. Runway use is defined in accordance with the definition in Paragraph 5.a.(2) on page 6. To further illustrate that definition, consider the following example:

An airport has the following runway configuration:



RUNWAY CONFIGURATION

Assume that the runways at this airport are normally used in four different ways as shown in the following diagrams (i.e., reflecting prevailing wind conditions, etc.):



⇨ ARRIVALS CAN OCCUR ON RUNWAY INDICATED.

➡ DEPARTURES CAN OCCUR ON RUNWAY INDICATED.

Each of the four diagrams represents a runway use. In this report, the symbol ⇨ is used to denote that arrivals can occur on the runway indicated, and the symbol ➡ is used to denote that departures can occur on the runway indicated. The lack of a symbol means that such operations will not occur.

A complete listing of runway uses is shown in Figure 2-2. Possible sources of runway use information at a particular airport include field observations, FAA air traffic control tower personnel, or airport management.

(3) Aircraft Mix. As defined in Chapter 1, aircraft mix is expressed in terms of four aircraft classes, i.e., A, B, C, and D. Sources of the mix of aircraft for a particular airport include air traffic forecasts, field surveys, and air traffic activity records.

For purposes of determining runway capacity using this chapter, information on aircraft mix must be converted to a mix index according to the following formula:

$$\text{Mix Index} = [\text{Percent of Aircraft in Class C}] + 3 \times [\text{Percent of Aircraft in Class D}]$$

or,

$$\text{Mix Index} = \text{Percent } (C+3D)$$

(4) Percent Arrivals and Percent Touch-and-Go. Percent arrivals and percent touch-and-go are computed according to the following formulae:

$$\text{Percent Arrivals} = \frac{A + \frac{1}{2}(T + G)}{A + D + (T + G)} \times 100$$

and.

$$\text{Percent Touch-and-Go} = \frac{(T + G)}{A + D + (T + G)} \times 100$$

where,

A = number of arrival operations in one hour
D = number of departure operations in one hour
T+G = number of touch-and-go operations in one hour

Sources of information concerning percent arrivals and percent touch-and-go for a particular airport include field surveys, air traffic forecasts, and published flight schedules.

(5) Exit Taxiway Location. Information on the location of exit taxiways is needed to determine capacities for certain runway uses. In this chapter it is assumed that, as a minimum, exit taxiways are located at each end of all runways.

b. Hourly Capacity of Taxiway Crossing an Active Runway. For determining the hourly capacity of a taxiway crossing an active runway, information on intersecting taxiway location, runway operations rate, and aircraft mix using the runway is required (see Paragraph 5.b on page 8). Sources of this information include airport base maps, field surveys, and air traffic activity reports.

c. Hourly Capacity of Gates. The following information is required for estimating the hourly capacity of gates: number and types of gates in each gate group, gate mix, and gate occupancy time (see Paragraph 5.c on page 9). Information on these items may be obtained from the airlines.

d. Hourly Capacity of an Airfield. For determining the hourly capacity of an airfield, information is needed concerning the capacity and the utilization of the three airfield components (i.e., runways, taxiways crossing active runways, and gates).

e. Annual Service Volume. For the calculation of annual service volume, it is necessary to compute hourly capacities for the various operating conditions (i.e., runway use, ceiling and visibility, etc.) that occur throughout the year. Also, it is necessary to develop information on monthly, daily, and hourly aircraft operations. These data may be approximated from air traffic activity records and air traffic forecasts.

f. Hourly Delay to Aircraft. For determining hourly delay to aircraft on an airfield, information is needed concerning the delay to aircraft on the three airfield components (i.e., runways, taxiways crossing active runways, and gates). The following information is required for estimating hourly delay to aircraft on each component of the airfield:

(1) Hourly Demand. Sources of hourly demand data for a particular airport include air traffic forecasts, field surveys, and/or air traffic activity records.

(2) Hourly Capacity. The hourly capacity of the component is a prerequisite to the determination of hourly delay to aircraft.

(3) Demand Profile Factor. The characteristics of demand within the hour are reflected in the demand profile factor. The demand profile factor is the percent of hourly demand occurring in the busiest 15-minute period, and is computed according to the following formula:

$$\text{Demand Profile Factor} = \frac{Q}{H} \times 100$$

where,

Q = demand by aircraft (i.e., operations) for use of the component in the busiest 15-minute period of the hour.

H = demand by aircraft (i.e., operations) for use of the component in the same hour.

Sources of information on the demand profile factor include field surveys during the busiest hours of the day and published airline schedules.

The demand profile factor for the high-activity airports primarily serving air carrier aircraft typically ranges from 35 to 45; for airports used primarily by general aviation aircraft, the demand profile factor typically ranges from 25 to 35.

g. Daily Delay to Aircraft. Estimates of daily delay to aircraft on each of the three airfield components (i.e., runways, taxiways crossing active runways, and gates) are required for a determination of daily delay on an airfield. The following information is needed for determining the daily delay on each airfield component:

(1) Hourly Delay to Aircraft. Information on the hourly delay to aircraft on the component is needed for those periods of time when hourly demands do not exceed the hourly capacity of the component.

(2) Hourly Demand. Hourly demands on the component for the hours of the day are essential for the determination of daily delay to aircraft.

(3) Hourly Capacity. The hourly capacity of the component for each hour of the day is required.

h. Annual Delay to Aircraft. Prerequisite to the determination of annual delay to aircraft on an airfield is the annual delay on the runway and gate components. The following information is required for estimating annual delay to aircraft on the runways or gates:

(1) Representative Daily Demands. Estimates of daily delay for various representative daily demands are aggregated in the determination of annual delay to aircraft. The selection of representative daily demands is described in Paragraph 29 on page 71.

(2) Annual Demand. Information on the annual demand on the component is essential for the determination of annual delay. Sources of annual demand data for a particular airport include air traffic forecasts and/or air traffic activity records.

(3) Seasonal Variation in Demand over the Year. The seasonal variation can be accounted for by determining the representative daily demands as described in Paragraph 29 on page 71.

(4) Hourly Demand During the Day. The percentage of daily demand in each hour may be derived from air traffic activity records or air traffic forecasts. These hourly percentages should be representative of daily activity throughout the year.

(5) Hourly Capacities. It is necessary to compute hourly capacities for the various runway uses occurring throughout the year. The percent of time each runway use occurs is also required; this information may be determined from discussions with FAA air traffic control personnel and/or airport management.

22. <u>PROCEDURE FOR DETERMINING HOURLY CAPACITY OF RUNWAYS.</u>[a] The following procedure is used in the determination of the hourly capacity of runways using Figures 2-3 through 2-64 located at the end of this chapter.

For each runway use under consideration:

a. Select the ceiling and visibility condition (VFR or IFR).

b. Identify the runway use from Figure 2-2. From this figure, find the appropriate figure for determining capacity.

c. Determine the mix index.

d. Determine the percent arrivals.

e. If VFR conditions, determine the percent touch-and-go.

f. Determine the location of exit taxiways.

g. Estimate the hourly capacity from the appropriate figure.

Examples to demonstrate the use of the procedure in the calculation of hourly capacities for several different runway configurations under different conditions are presented in the next six pages:

Example	Hourly Capacity for
1	Single Runway, VFR
2	Single Runway, VFR
3	Parallel Runways, VFR
4	Intersecting Runways, VFR

---

a. Corresponding procedures for determining the hourly, daily, and annual delays to aircraft on runways are presented in Paragraphs 27 through 29, beginning on page 47.

Example 1, Hourly Capacity,[a] Single Runway, VFR

Determine the hourly capacity of a single runway (10,000 feet long) in VFR under the following conditions:

Aircraft Mix: 35% A, 30% B, 30% C, and 5% D
Percent Arrivals: 50%
Percent Touch-and-Go: 0%
Exit Taxiway Locations: 3,100 feet, 3,900 feet, 4,700 feet, 5,500 feet, 6,250 feet, 7,000 feet, and 10,000 feet from arrival threshold

From Figure 2-2, select Runway Use Diagram No. 1. The corresponding figure number for estimating capacity is Figure No. 2-3 (as illustrated in the reproduction of Figure 2-2, below).

RUNWAY USE DIAGRAM	DIAG. NO.	RUNWAY SPACING[A] IN FEET (s)	FIGURE NO. FOR CAPACITY VFR	FIGURE NO. FOR CAPACITY IFR	FIGURE NO. FOR DELAY VFR	FIGURE NO. FOR DELAY IFR
	1	N.A.	2-3	2-43	2-70	2-85
	2	700[B] OR MORE	2-4	2-44	2-71	2-86

The mix index for the assumed aircraft mix is Percent (C+3D) = 30 + 3 x 5 = 45.

From Figure 2-3, determine hourly capacity:

C* x T x E = Hourly capacity:

where,

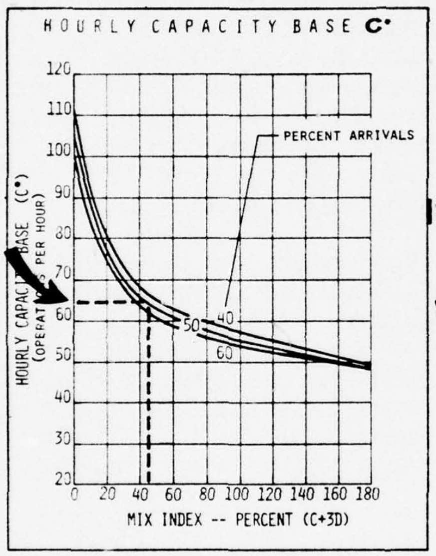
C* = Hourly Capacity Base
T = Touch-and-Go Factor
E = Exit Factor

---

a. Examples 10 and 13 on pages 49 and 57 illustrate the procedures for the calculation of hourly and daily delay for similar conditions as Example 1.

For the assumed aircraft mix and percent arrivals, the hourly capacity base (**C***) = 65 operations per hour. For zero percent touch-and-go, the touch-and-go factor (**T**) = 1.00. With four exit taxiways located between 3,000 feet and 5,500 feet from the arrival runway threshold, the exit factor (**E**) = 1.00.

Therefore, hourly capacity = 65 x 1.0 x 1.0 = 65 operations per hour (as illustrated on the reproduction of Figure 2-3, below).



TOUCH & GO FACTOR **T**

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	[illegible]
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.20
31 to 40	0 to 10	1.31
41 to 50	0 to 10	1.40

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: *(a) within appropriate exit range, and (b) separated by at least 750 feet*
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.72	0.87	0.94	0.70	0.86	0.94	0.67	0.84	0.92
21 to 50	3000 to 5500	0.79	0.86	0.94	0.76	0.84	0.93	0.72	0.81	0.90
51 to 80	3500 to 6500	0.79	0.86	0.92	0.76	0.83	0.91	0.73	0.83	0.90
81 to 120	5000 to 7000	0.82	0.89	0.93	0.80	0.88	0.94	0.77	0.86	0.93
121 to 180	5500 to 7500	0.86	0.94	0.98	0.82	0.91	0.96	0.79	0.91	0.97

FIGURE 2-3 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 1, 54 FOR VFR CONDITIONS

Example 2, Hourly Capacity, Single Runway, VFR

Determine the hourly capacity of the runway in Example 1 on page 28, under the following conditions:

Aircraft Mix: 35% A, 30% B, 30% C, and 5% D
Percent Arrivals: 50%
Percent Touch-and-Go: 15%
Exit Taxiway Locations: 4,500 feet and 10,000 feet from arrival threshold

The mix index for the assumed aircraft mix is Percent (C+3D) = 30 + 3 x 5 = 45. From Figure 2-3, the hourly capacity base (**C***) in VFR conditions is 65 operations per hour. Also from Figure 2-3 for 15% touch-and-go, the touch-and-go factor (**T**) is 1.10. With one exit taxiway located between 3,000 feet and 5,500 feet from the arrival runway threshold, the exit factor (**E**) is 0.84.

Therefore, the hourly capacity of the runway is 65 x 1.10 x 0.84 = 60 operations per hour.

It should be noted that with the addition of three exit taxiways appropriately spaced between 3,000 feet and 5,500 feet from the arrival threshold, the exit factor (**E**) could be increased to 1.00. Thus, the addition of exit taxiways could increase hourly runway capacity for the conditions in this example to 65 x 1.10 x 1.00 = 72 operations per hour, an increase of some 20%.

Also it should be noted that the effect on capacity of varying percent arrivals is illustrated graphically on each of the hourly capacity figures (Figures 2-3 to 2-64). For instance, if the percent arrivals in this example was changed from 50% to 40%, the hourly capacity base (**C***) would increase from 65 operations per hour to 67 operations per hour, a difference of some 3%. For other runway uses this difference can be much larger.

Example 3, Hourly Capacity, Parallel Runways, VFR

Assume that a new parallel runway (10,000 feet long) is added to the airport in Example 1 on page 28. The spacing between the two runways is 3,800 feet, as illustrated below.

Assume the following two runway uses. In this example, it is assumed that operations do not occur off the west end of the new runway, because of local constraints.

" EAST FLOW " " WEST FLOW "

Note that from Paragraph 21.a.(2) on page 22, the symbol ⇨ is used to denote that arrivals can occur on the runway indicated, and the symbol ➡ is used to denote that departures can occur on the runway indicated.

Determine the hourly capacity of the two runways in VFR under the following conditions:

Aircraft Mix: 35% A, 30% B, 30% C, and 5% D
Percent Arrivals: 50%
Percent Touch-and-Go: 0%
Exit Taxiway Locations for East Flow:
 Existing Runway--3,100 feet, 3,900 feet, 4,700 feet, 5,500 feet, 6,250 feet, 7,000 feet, and 10,000 feet from arrival threshold
Exit Taxiway Locations for West Flow:
 Existing Runway--3,000 feet, 3,750 feet, 4,500 feet, 5,300 feet, 6,100 feet, 6,900 feet, and 10,000 feet from arrival threshold
 New Runway--4,500 feet, 5,500 feet, and 10,000 feet from arrival threshold

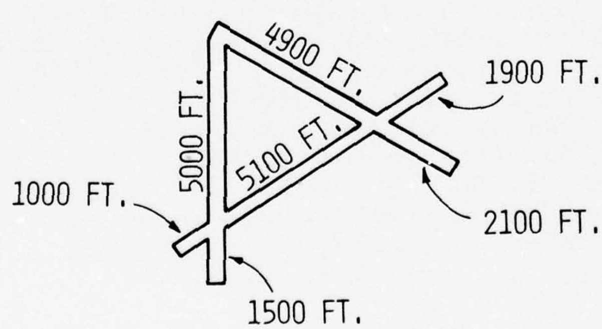
From Figure 2-2, Runway Use Diagram No. 5 is selected for the "east flow" and Runway Use Diagram No. 7 is selected for the "west flow." (Note: the "west flow" illustration above coincides with the reverse image of Runway Use Diagram No. 7.) The corresponding figure number for estimating capacity for the "east flow" is Figure 2-6, and for the "west flow" is Figure 2-8. The mix index for the assumed aircraft mix is Percent (C+3D) = 30 + 3 x 5 = 45.

From Figure 2-6, the hourly capacity base (**C***) of the two runways for "east flow" is 91 operations per hour. Also, from Figure 2-6, for zero percent touch-and-go, the touch-and-go factor (**T**) = 1.00. With four exit taxiways located between 3,000 feet and 5,500 feet from the arrival threshold of the existing runway, the exit factor (**E**) = 1.00. As a result, hourly capacity for "east flow" is 91 x 1.00 x 1.00 = 91 operations per hour.

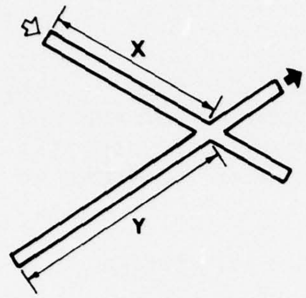
From Figure 2-8, the hourly capacity base (**C***) of the two runways for "west flow" is 120 operations per hour; the touch-and-go factor (**T**) = 1.00 for zero percent touch-and-go. With four exit taxiways located between 3,000 feet and 5,500 feet from the arrival threshold of the existing runway and with two exit taxiways within the same range on the new runway, the average number of exits (**N**) = $\frac{4+2}{2}$ = 3. Therefore, from Figure 2-8, the exit factor (**E**) is 0.96. As a result, hourly capacity for "west flow" is 120 x 1.00 x 0.96 = 115 operations per hour.

<u>Example 4, Hourly Capacity, Intersecting Runways, VFR</u>

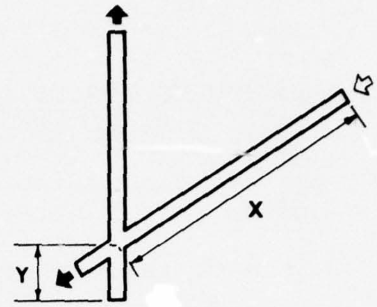
Consider an intersecting runway configuration as illustrated below.



The following runway uses are in effect:



CASE A



CASE B

Determine the hourly capacity in VFR of the intersecting runways under the following conditions:

Aircraft Mix: 50% A, 30% B, 20% C, and 0% D
Percent Arrivals: 50%
Percent Touch-and-Go: 0%
Exit Taxiway Location for Case A: 1,500 feet, 2,500 feet, 3,900 feet, 4,900 feet, and 7,000 feet from arrival threshold
Exit Taxiway Location for Case B: 1,900 feet, 2,900 feet, 4,000 feet, 7,000 feet, and 8,000 feet from arrival threshold

Before selecting the appropriate runway use diagrams from Figure 2-2, it is necessary to determine the intersection distances "x" and "y" for both cases. For Case A, "x" and "y" equal 4,900 feet and 6,100 feet, respectively; for Case B, "x" and "y" equal 7,000 feet and 1,500 feet, respectively.

Therefore, from Figure 2-2, Runway Use Diagram No. 47 is selected for Case A, and Runway Use Diagram No. 45 is selected for Case B. The corresponding figure number for estimating capacity for Case A is Figure 2-31 and for Case B is Figure 2-29. The mix index for the assumed mix is Percent (C+3D) = 20 + 3 x 0 = 20. From these figures, for zero percent touch-and-go, the touch-and-go factor (**T**) is equal to 1.00.

From Figure 2-31, the hourly capacity base (**C***) for Case A in VFR is 78 operations per hour. With two exit taxiways between 2,000 feet and 4,000 feet from the arrival threshold, the exit factor (**E**) = 0.94. Therefore, hourly capacity = 78 x 1.00 x 0.94 = 73 operations per hour.

From Figure 2-29, the hourly capacity base (**C***) for Case B in VFR is 82 operations per hour. With two exit taxiways between 2,000 feet and 4,000 feet from the arrival threshold, the exit factor (**E**) = 0.93. Therefore, hourly capacity = 82 x 1.00 x 0.93 = 76 operations per hour.

23. PROCEDURES FOR DETERMINING HOURLY CAPACITY OF A TAXIWAY CROSSING AN ACTIVE RUNWAY. The following procedure is used in the determination of hourly capacity of a taxiway crossing using Figures 2-65 and 2-66 located at the end of this chapter.

For each taxiway crossing under consideration:

a. Determine the distance of the taxiway crossing from the threshold of the active runway.

b. Estimate the operations rate on the active runway (i.e., arrival, departure, and touch-and-go operations per hour). The operations rate cannot exceed the hourly capacity of the runway.

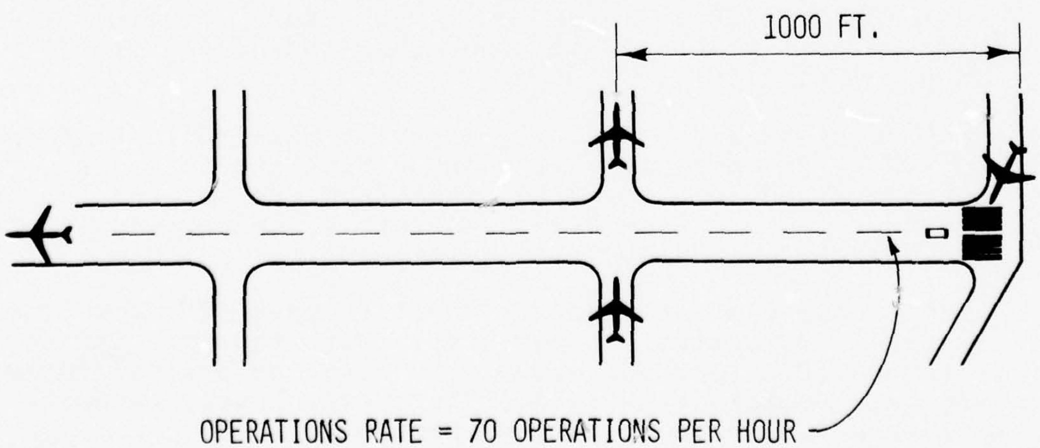
c. Determine the mix index on the active runway.

d. If operations on the active runway include arrivals, as well as departures and/or touch-and-gos, estimate the hourly capacity of the taxiway from Figure 2-65.

e. If operations on the active runway do not include arrivals, but only departures and/or touch-and-gos, estimate the hourly capacity of the taxiway from Figure 2-66.

Example 5, Hourly Capacity, Taxiway Crossing an Active Runway With Arrivals

Determine the hourly capacity of a taxiway crossing an active runway 1,000 feet from the threshold of the runway, as illustrated below.



The active runway is used for arrivals, departures, and touch-and-gos. The peak hour operations rate on the runway is 70 operations per hour and the mix index on the runway is 40.

Figure 2-65 is appropriate because operations on the active runway include arrivals, departures, and touch-and-gos; the chart on the lower left-hand portion of the figure (i.e., Figure 2-65C.) is appropriate because the assumed operations rate on the runway (i.e., 70 operations per hour) is between 56 to 75 operations per hour.

From Figure 2-65C. the hourly capacity of the taxiway is 35 operations per hour (as illustrated in the reproduction of Figure 2-65C. below).

FIGURE 2–65C

RUNWAY OPERATIONS RATE
56 TO 75 OPERATIONS PER HOUR

FIGU

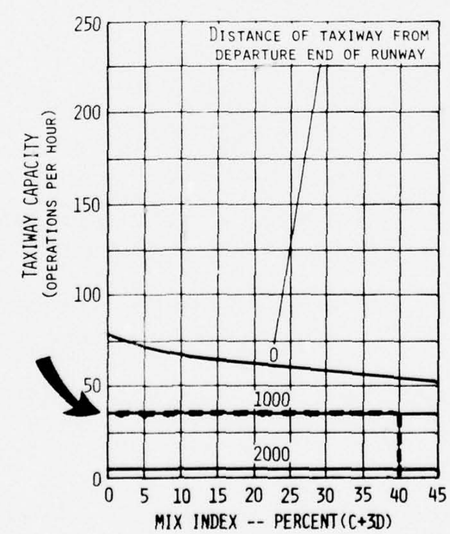


FIGURE 2–65 HOURLY CAPACITY OF A TA
RUNWAY WITH ARRIVALS

24. <u>PROCEDURES FOR DETERMINING HOURLY CAPACITY OF GATES</u>. The following procedure is used in the determination of hourly capacity of gates using Figure 2-67 located at the end of this chapter.

For each gate group, perform the following steps:

a. Determine total number of gates in the gate group.

b. Determine the gate mix (i.e., the percent of non-widebody aircraft using the gates in the group).

c. Determine the percent of gates that can accommodate widebody aircraft (e.g., B-747, DC-10, L-1011).

d. Determine the average gate occupancy time (in minutes) for non-widebody aircraft.

e. If operations include widebody aircraft, determine the average gate occupancy time for widebody aircraft.

f. If operations include widebody aircraft, determine the gate occupancy ratio, R, by the following formula:

$$R = \frac{r_w}{r_n}$$

where,

r_w = average gate occupancy time for widebody aircraft

r_n = average gate occupancy time for non-widebody aircraft

g. If operations do not include widebody aircraft (i.e., non-widebody aircraft only), assume R = 1.0.

h. Estimate the hourly capacity of gates from Figure 2-67.

To determine hourly capacity of all gate groups at an airport, add the hourly capacities of all gate groups.

Example 6, Hourly Capacity, Single Gate Group

Determine the hourly capacity of the gates at an airport served by one airline (i.e., there is only one gate group) under the following conditions:

Number of Gates: 10
Gate Mix: 60% non-widebody aircraft
Percent Gates that Can Accommodate Widebody Aircraft: 20% (i.e., 2 gates)
Gate Occupancy Time for Non-Widebody Aircraft: 40 minutes
Gate Occupancy Time for Widebody Aircraft: 55 minutes

The gate occupancy ratio, R, for the assumed gate occupancy times is $\frac{r_w}{r_n} = 55/40 = 1.38$.

From Figure 2-67, determine hourly capacity:

G* x **S** x **N** = Hourly Capacity

where,

G* = Hourly Gate Capacity Base
S = Gate Size Factor
N = Number of Gates

Note that on the left-half of Figure 2-67, information is presented for values of R = 1.0, 1.2, 1.4, and 1.6. In this example, therefore, the value of R should be considered to be 1.4, i.e., the value of 1.38 for the assumed conditions is closer to 1.4 than to 1.2.

As a result, for the assumed gate occupancy times and gate mix, the hourly capacity base (**G***) = 2.6 operations per hour per gate; with the assumed percent of gates that accommodate widebody aircraft, the gate size factor (**S**) = 0.43.

Therefore, the hourly capacity of the gates is 2.6 x 0.43 x 10 = 11 aircraft per hour (as illustrated in the reproduction of Figure 2-67, on the following page.

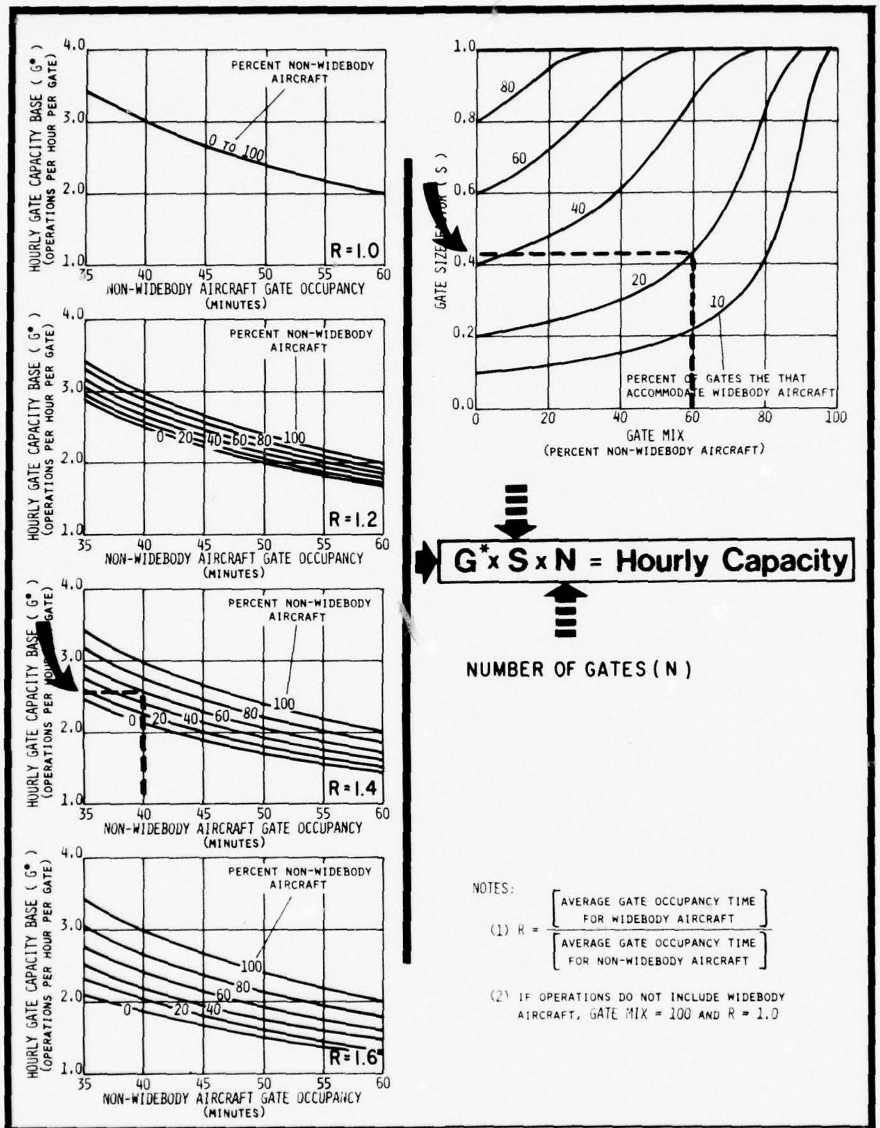


FIGURE 2-67 HOURLY CAPACITY OF GATES

Example 7, Hourly Capacity, Two Gate Groups

Determine the hourly capacity of the gates at an airport with two airlines and two gate groups, as follows:

Airline A Gate Group

Number of Gates: 10
Gate Mix: 80% non-widebody aircraft
Percent Gates that Can Accommodate Widebody Aircraft: 20% (i.e., 2 gates)
Gate Occupancy Time for Non-Widebody Aircraft: 40 minutes
Gate Occupancy Time for Widebody Aircraft: 52 minutes

Airline B Gate Group

Number of Gates: 3
Gate Mix: 100% non-widebody aircraft
Percent Gates that Can Accommodate Widebody Aircraft: 0% (i.e., no gates)
Gate Occupancy Time for Non-Widebody Aircraft: 45 minutes
Gate Occupancy Time for Widebody Aircraft: Not applicable to this example

For airline A, the gate occupancy ratio, R, for the assumed times is $\frac{r_w}{r_n} = \frac{52}{40} = 1.3$ (Note that for airline A, the value of R for the assumed conditions is equally close to the presented values of 1.2 and 1.4. For such cases, the lower of the presented values should be used (i.e., for airline A the value of R should be considered to be 1.2). For airline B, operations do not include widebody aircraft; therefore, the gate occupancy ratio, R, is assumed to be 1.0.

From Figure 2-67, the following is determined:

	Hourly Capacity Base (G*)	Gate Size Factor (S)	Number of Gates (N)	Hourly Capacity of Gate Groups G* x S x N
Airline A	2.9	0.85	10	25 operations per hour
Airline B	2.7	1.00	3	8 operations per hour
				33 operations per hour

The hourly capacity of all gates at the airport is the sum of the capacities of the gate groups, or 33 operations per hour.

25. PROCEDURE FOR DETERMINING HOURLY CAPACITY OF AN AIRFIELD. The hourly capacity of an airfield is governed by the capacity of its constraining component. To determine the hourly capacity of an airfield:

a. Determine the hourly capacity of each of the airfield components (i.e., runways, taxiways crossing active runways, and gates) in accordance with procedures in Paragraphs 22, (or Chapter 3), 23, and 24.

b. Estimate the percent of airfield operations that occur on each component by dividing the number of operations that occur on each component in one hour by the number of operations that occur on the runway component in one hour.

c. Identify the constraining component which governs the operations rate on the entire airfield by dividing the hourly capacity of each component (Paragraph 25.a) by the percent of airfield operations that occur on the component (Paragraph 25.b). The component which yields the lowest quotient governs the hourly capacity of the airfield.

d. The hourly capacity of the airfield equals the lowest quotient from Paragraph 25.c above.

Example 8, Hourly Capacity of an Airfield, VFR

From field surveys, the following was determined to be typical of busy period conditions at an airport in VFR:

	Number of Operations per Hour on Component
Runways	50
Gates	25
Taxiway Crossing Active Runway	3

Determine the hourly capacity of the airfield in VFR, assuming the capacities of the airfield components in VFR are as follows:

	Hourly Capacity of Component (operations per hour)
Runways	80
Gates	60
Taxiway Crossing Active Runway	10

To estimate the percent of airfield operations on each component, the number of operations on each component is divided by the number of operations on the runway component as follows:

	Number of Operations on Component ÷ Number of Operations on Runways	Percent of Airfield Operations on Component
Runways	50 ÷ 50 =	100%
Gates	25 ÷ 50 =	50
Taxiway Crossing Active Runway	3 ÷ 50 =	6

The percentages above indicate that 50% of the operations on the airfield are by air carrier aircraft that use the gates and that 6% of the operations on the airfield use the taxiway crossing.

To determine the constraining component, divide the hourly capacity of each component by the percent of airfield operations utilizing the component as follows:

	Capacity ÷ Percent of Airfield Operations	Quotient
Runways	80 ÷ 100% =	80
Gates	60 ÷ 50% =	120
Taxiway Crossing Active Runway	10 ÷ 6% =	167

The lowest quotient (80) is for the runway component; consequently, the constraining component is the runway which governs the operations rate on the airfield. Therefore, the hourly capacity of the airfield equals 80 operations per hour.

26. PROCEDURE FOR DETERMINING ANNUAL SERVICE VOLUME OF RUNWAYS. The following procedure is used in the determination of the annual service volume of the runway component:

a. Determine "weighted hourly capacity" of the runway component in accordance with the following steps:

(1) Identify the various operating conditions (e.g., VFR, Runway Use Diagram No. 4; IFR, Runway Use Diagram No. 1; etc.) under which the airfield component may be used during a year. Include those conditions when weather is below landing or takeoff minima and the hourly capacity of the runways is zero.[a]

(2) Determine the percent of time that each operating condition occurs annually. Any condition that occurs less than 2% of the time may be ignored if the percent is added to the percent of another condition.

---

a. For airports used on a seasonal or part-time basis, also include those conditions when the airport is closed to operations and the hourly capacity of the runways is zero.

(3) Determine the hourly capacity of the runway component for each operating condition in accordance with procedures in Paragraph 22 (or Chapter 3), as appropriate.

(4) Identify the hourly capacity for the operating condition that occurs the greatest percentage of the year (i.e., the predominant capacity).

(5) Determine the weight to be applied to the capacity for each operating condition from the following table:

Percent of Predominant Capacity[a]	Weight			
	Mix Index in VFR	Mix Index in IFR		
	0 to 180	0 to 20	21 to 50	51 to 180
91 or more	1	1	1	1
81 to 90	5	1	3	5
66 to 80	15	2	8	15
51 to 65	20	3	12	20
0 to 50	25	4	16	25

a. Predominant capacity is the hourly capacity for the operating condition that occurs the greatest percentage of the year.

(6) Calculate weighted hourly capacity, C_W, of the runway component by the following formula:

$$C_W = \frac{(P_1 \times C_1 \times W_1) + (P_2 \times C_2 \times W_2) + \ldots + (P_N \times C_N \times W_N)}{(P_1 \times W_1) + (P_2 \times W_2) + \ldots + (P_N \times W_N)}$$

where,

$P_1, P_2, \ldots, P_N$ = the percentage of the year that operations are carried on under Conditions 1, 2, . . . ,N.

$C_1, C_2, \ldots, C_N$ = the hourly capacity corresponding to Conditions 1, 2, . . ., N.

$W_1, W_2, \ldots, W_N$ = the weight determined from the table on page 43 corresponding to Conditions 1, 2, . . ., N

b. Determine the ratio of the annual aircraft operations to average daily aircraft operations during the peak month (i.e., the daily ratio). If data are not available for determining the daily ratio, typical values are as follows:

Mix Index	Daily Ratio
0 to 20	280 to 310
21 to 50	300 to 320
51 to 180	310 to 350

c. Determine the ratio of average daily aircraft operations to average peak hour aircraft operations of the peak month (i.e., the hourly ratio). If data are not available for determining the hourly ratio, typical values are as follows:

Mix Index	Hourly Ratio
0 to 20	7 to 11
21 to 50	10 to 13
51 to 180	11 to 15

d. Compute annual service volume, ASV, from the following formula:

$$ASV = C_W \times D \times H$$

where,

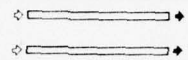
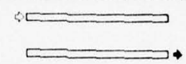
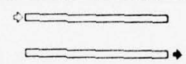
C_W = Weighted hourly capacity

D = Daily ratio

H = Hourly ratio

Example 9, Annual Service Volume, Runways

Determine the annual service volume of a parallel runway configuration under the following conditions:

	Operating Condition				
No.	Ceiling and Visibility	Runway Use	Mix Index	Percentage of Year	Hourly Capacity[a]
1	VFR		150	70%	93
2	VFR		150	20%	72
3	IFR		180	8%	62
4	IFR	Below minima	180	2%	0

a. Operations per hour.

Assume that historical monthly traffic records indicate the following:

Month	Monthly Aircraft Operations	No. of Days in Month	Average Daily Aircraft Operations
January	30,938	31	998
February	27,244	28	973
March	30,442	31	982
April	29,850	30	995
May	31,310	31	1,010
June	30,600	30	1,020
July	31,775	31	1,025
August	32,550	31	1,050
September	30,660	30	1,022
October	31,682	31	1,005
November	29,460	30	982
December	31,093	31	1,003
Total Annual Aircraft Operations	367,604		

Also assume that daily traffic records for August (the peak month) indicate the following:

Date	Daily Aircraft Operations	Peak Hour	Peak Hour Aircraft Operations	Date	Daily Aircraft Operations	Peak Hour	Peak Hour Aircraft Operations
August 1	1,095	1500 to 1600	78	August 16	1,093	1100 to 1200	82
2	1,135	1200 to 1300	83	17	1,045	1600 to 1700	81
3	1,040	1600 to 1700	65	18	983	1600 to 1700	70
4	992	1600 to 1700	80	19	1,091	1500 to 1600	83
5	1,012	1500 to 1600	71	20	996	1500 to 1600	71
6	1,055	1600 to 1700	71	21	1,082	1600 to 1700	77
7	1,087	1700 to 1800	77	22	1,067	1600 to 1700	84
8	990	1500 to 1600	65	23	1,096	1200 to 1300	70
9	1,123	1200 to 1300	83	24	1,031	1600 to 1700	71
10	1,042	1500 to 1600	77	25	987	1600 to 1700	68
11	993	1600 to 1700	72	26	1,079	1500 to 1600	77
12	1,093	1500 to 1600	78	27	1,011	1500 to 1600	72
13	1,053	1500 to 1600	68	28	1,077	1600 to 1700	74
14	1,040	1600 to 1700	77	29	1,043	1600 to 1700	70
15	1,088	1700 to 1800	77	30	1,069	1600 to 1700	72
				31	1,012	1600 to 1700	72
				Total	32,550		2,319
				Average	1,050		75

For the assumed conditions, the predominant capacity occurs in Operating Condition No. 1 and is 93 operations per hour. From the table in Paragraph 26.a.(5) on page 43, the following weights for each operating condition are determined.

Operating Condition No.	Hourly Capacity (operations per hour)	Percent of Predominant Capacity	Weight
1	93	100	1
2	72	77	15
3	62	67	15
4	0	0	25

Therefore, in this example the weighted hourly capacity is:

$$C_W = \frac{(P_1 \times C_1 \times W_1) + (P_2 \times C_2 \times W_2) + (P_3 \times C_3 \times W_3) + (P_4 \times C_4 \times W_4)}{(P_1 \times W_1) + (P_2 \times W_2) + (P_3 \times W_3) + (P_4 \times W_4)}$$

$$= \frac{(0.70 \times 93 \times 1) + (0.20 \times 72 \times 15) + (0.08 \times 62 \times 15) + (0.02 \times 0 \times 25)}{(0.70 \times 1) + (0.20 \times 15) + (0.08 \times 15) + (0.02 \times 25)}$$

= 66 operations per hour

For the assumed condition, the ratio of annual aircraft operations to average daily operations during the peak month is:

$$\text{Daily Ratio} = \frac{367{,}604}{1{,}050} = 350,$$

and for the assumed conditions, the ratio of average daily aircraft operations to average peak hour aircraft operations of the peak month is:

$$\text{Hourly Ratio} = \frac{1{,}050}{75} = 14.$$

Therefore, the annual service volume is:

$$\begin{aligned} ASV &= C_W \times D \times H \\ &= 66 \times 350 \times 14 \\ &= 323{,}400 \text{ operations per year} \end{aligned}$$

27. PROCEDURE FOR DETERMINING HOURLY DELAY TO AIRCRAFT ON RUNWAYS, TAXIWAYS, GATES, AND AIRFIELD. The following procedure is used in the determination of hourly delay to aircraft using Figures 2-68 through 2-102 located at the end of this chapter.

This procedure is applicable only when the hourly demand(s) on the component(s) of the airfield (i.e., runways, taxiways, and gates) does not exceed the hourly capacity(s) of the component(s). If the hourly demand(s) on the component(s) exceeds the hourly capacity(s) of one or more of the components, it is more appropriate to consider delay to aircraft

for a period greater than an hour; therefore, the procedure in Paragraph 28, on page 58 should be used.

a. Hourly Delay to Aircraft on Runways. For the runway component under consideration:

(1) Identify the runway use from Figure 2-2. From this figure, find the appropriate figure for delay.

(2) Estimate the hourly demand on the runway component.

(3) Determine the hourly capacity of the runway component in accordance with procedures in Paragraph 22.

(4) Calculate the ratio of hourly demand to hourly capacity (i.e., the hourly D/C ratio), for the runway component.

(5) Determine the arrival delay index and the departure delay index from the appropriate figure.

(6) Calculate the arrival delay factor, ADF, by the following formula:

$$ADF = ADI \times [D/C]$$

where:

ADI = arrival delay index
D/C = hourly D/C ratio

(7) Calculate the departure delay factor, DDF, by the following formula:

$$DDF = DDI \times [D/C]$$

where:

DDI = departure delay index
D/C = hourly D/C ratio

(8) Determine the demand profile factor in accordance with the procedure presented in Paragraph 21.f(3) on page 25.

(9) Estimate the average hourly delay for arrival and departure aircraft from Figure 2-68.

(10) Compute the total hourly delay to aircraft, DTH, by the following formula:

$$DTH = HD \left\{ [PA \times DAHA] + [(1 - PA) \times DAHD] \right\}$$

where,

HD = hourly demand on the runway component

PA = percent arrivals ÷ 100

DAHA = average hourly delay per arrival aircraft on the runway component

DAHD = average hourly delay per departure aircraft on the runway component

Example 10, Hourly Delay to Aircraft on a Single Runway, VFR

Determine the total hourly delay to aircraft in VFR using the single runway in Example 1 on page 28 under the following conditions:

Hourly Demand: 59 operations per hour
Peak 15-Minute Demand: 21 operations
Hourly Capacity: 65 operations per hour
Percent Arrivals: 50%

From Figure 2-2, select Runway use Diagram No. 1. The corresponding figure for estimating delay is Figure 2-70. (as illustrated in the reproduction of Figure 2-2 below).

RUNWAY USE DIAGRAM	DIAG. NO.	RUNWAY SPACING[A] IN FEET (S)	FIGURE NO. FOR CAPACITY VFR	FIGURE NO. FOR CAPACITY IFR	FIGURE NO. FOR DELAY VFR	FIGURE NO. FOR DELAY IFR
	1	N.A.	2-3	2-43	2-70	2-85
	2	700[B] OR MORE	2-4	2-44	2-71	2-86
				2-44	2-72	2-86

The ratio of hourly demand to hourly capacity is
59 ÷ 65 = 0.91.

From Figure 2-70, for a mix index of 45, the arrival delay index is 0.71, and the departure delay index is 0.88 (as illustrated in the reproduction of Figure 2-70, below).

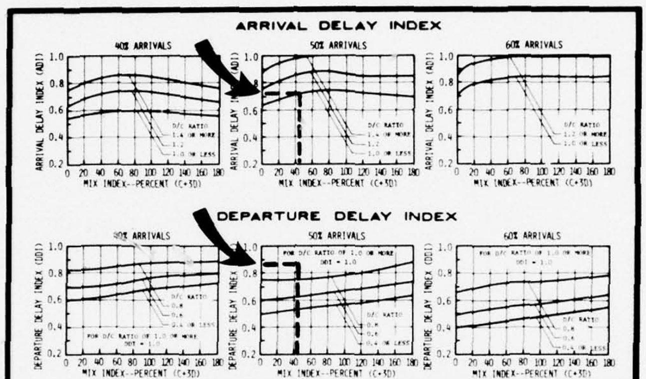


FIGURE 2-70 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 1, 9, 10, 11, 12, 30, 31, 42, 47, 48, 53, 54, 66, 68, 69, 70,71 FOR VFR CONDITIONS

Thus, the arrival delay factor is 0.71 x 0.91 = 0.65, and the departure delay factor is 0.88 x 0.91 = 0.8.

For the assumed peak 15-minute demand, the demand profile factor is (21 ÷ 52) x 100 = 40. Therefore, from Figure 2-68, the average hourly delay to arrival aircraft on the runway is 2.2 minutes, and the average hourly delay to departure aircraft on the runway is 3.8 minutes (as illustrated in the reproduction of Figure 2-68 on the next page).

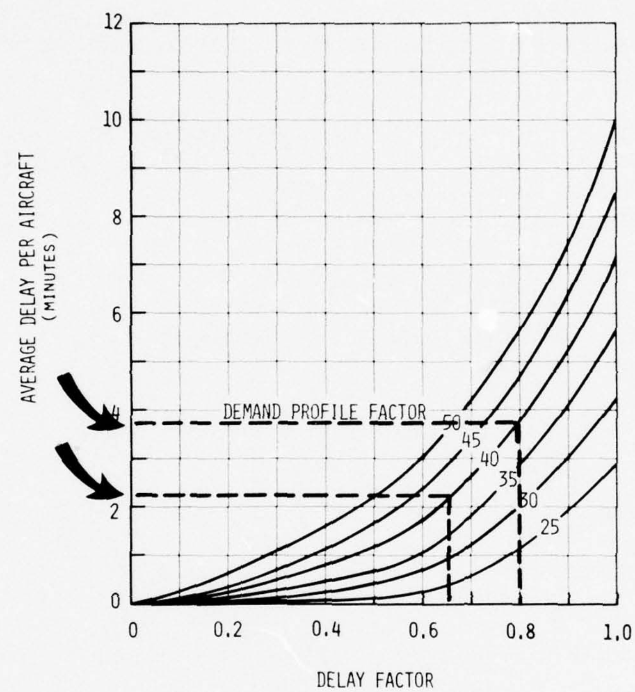


FIGURE 2-68 AVERAGE AIRCRAFT DELAY IN AN HOUR

Therefore, the total hourly delay to aircraft on the runway is:

$$DTH = HD \left\{[PA \times DAHA] + [(1 - PA) \times DAHD]\right\}$$

$$= 52 \left\{[0.50 \times 2.2] + [(1 - 0.50) \times 3.8]\right\} = 156 \text{ minutes.}$$

Example 11, Hourly Demand Corresponding to a Specified Level of Average Hourly Aircraft Delay, VFR

Determine the hourly demand (i.e., aircraft operations rate) corresponding to an average delay of three minutes to departure aircraft in VFR, for a single runway under the following conditions:

Hourly Capacity: 49 operations per hour
Aircraft Mix: 5% A, 5% B, 45% C, and 45% D
Percent Arrivals: 50%
Demand Profile Factor: 35

From Figure 2-2, select Runway Use Diagram No. 1. The corresponding figure for estimating delay is Figure 2-70. The mix index is Percent (C+3D) = 45 + 3 x 45 = 180.

In determining an hourly demand corresponding to a specified level of average delay, a brief trial and error procedure is used. This procedure involves initially selecting an estimated demand and determining the associated average delay. If the average delay associated with the estimated demand is higher than the specified level of average delay, then the estimated demand is reduced and the process is repeated. Conversely, if the average delay associated with the estimated demand is lower than the specified level of average delay, then the estimated demand is increased and the process is repeated. The process is repeated until the average delay associated with the estimated demand equals the specified level of delay.

In this example, assume the initial estimated demand is 49 operations per hour.

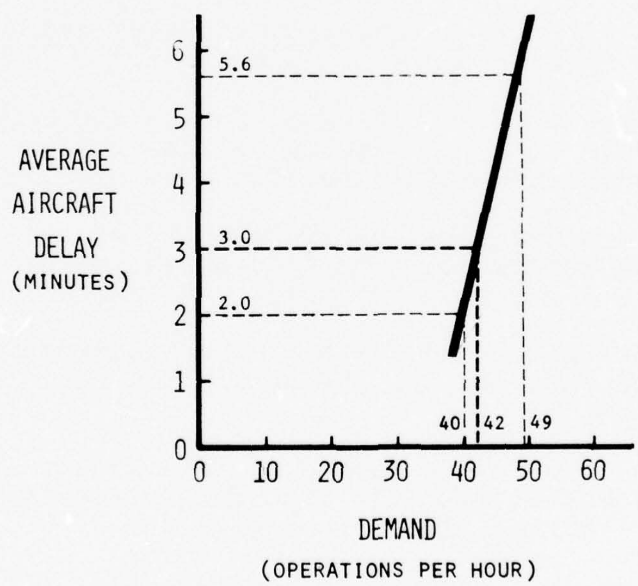
The ratio of hourly demand to hourly capacity is 49 ÷ 49 = 1.00. From Figure 2-70, the departure delay index is 1.00. For the initial estimated demand, the departure delay factor is 1.00 x 1.00 = 1.00. Therefore, from Figure 2-68, the average delay to departure aircraft on the runways associated with the initial estimated demand is 5.6 minutes per aircraft.

Because the average delay associated with the initial estimated demand is higher than the specified level of delay, the process is repeated with a lower demand.

Assume for this example that the second estimated demand is 40 operations per hour. The ratio of hourly demand to hourly capacity is 40 ÷ 49 = 0.82. From Figure 2-70, the departure delay index is 0.88. For the second estimated demand, the departure delay factor is 0.88 x 0.82 = 0.72. Therefore, from Figure 2-68, the average delay to departure aircraft on the runways associated with the second estimated demand is 2.0 minutes per aircraft.

Because the delay associated with the second estimated demand is lower than the specified level of delay, the process is repeated with a higher demand.

To assist in making the third estimated demand, it is possible to graphically interpolate from the results of the previous estimates as follows:



Using a third estimated demand of 43 operations per hour, the ratio of hourly demand to hourly capacity is 42 ÷ 49 = 0.86. From Figure 2-70, the departure delay index is 0.94. For the third estimated demand, the departure delay factor is 0.94 x 0.86 = 0.81. Therefore, from Figure 2-68, the average delay to departure aircraft on the runways associated with the third estimated demand is 3.0 minutes per aircraft.

As a result, the hourly demand corresponding to an average delay of three minutes to departure aircraft on the runways is 42 operations per hour. (As a matter of information, the average delay to arrival aircraft on the runways is 1.1 minutes when the demand is 42 operations per hour for the conditions assumed in this example.)

It should be noted that the trial and error procedure described in this example is applicable to those cases where the specified average delay is associated with a demand that does not exceed capacity. In the event the average delay specified is associated with a demand exceeding capacity, delay must be considered for a "saturated period" of two hours or more as described in Paragraph 28.c on page 59. In such cases, demand in each hour of the saturated period may vary and must be considered; therefore, no single hourly demand can be associated with a specified average hourly delay.

b. Hourly Delay to Aircraft on Taxiways and Gates. For each component under consideration:

(1) Estimate the hourly demand on the component. Note that the demands on the various components may differ for the same hour.

(2) Determine the hourly capacity of the component in accordance with procedures in Paragraphs 23 or 24 on pages 34 or 36, as appropriate.

(3) Calculate the ratio of hourly demand to hourly capacity (i.e., the hourly D/C ratio) for the component.

(4) Determine the demand profile factor in accordance with the procedure presented in Paragraph 21.f.(3) on page 25.

(5) Estimate the average hourly delay per aircraft on the component from Figure 2-68. Note the delay factor for the taxiway or gate components is equal to the hourly D/C ratio.

(6) Compute the total hourly delay, DTH, to aircraft on the component by the following formula:

$$DTH = HD \times DAH$$

where,

HD = hourly demand on the taxiway component, or one-half[a] of the hourly demand on the gate component, as appropriate

DAH = average hourly delay per aircraft on the component

c. Hourly Delay to Aircraft on the Airfield. To determine the total hourly delay to aircraft on the airfield:

(1) Determine the hourly delay to aircraft on each component of the airfield in accordance with procedures in Paragraphs 27.a and 27.b on pages 48 and 54.

(2) Compute the total hourly delay to aircraft on the airfield by adding the hourly delay for each component.

Example 12, Hourly Delay to Aircraft on Airfield, VFR

Determine the total hourly delay to aircraft in VFR on an airfield consisting of the single runway in Examples 1 and 10 and the 13 gates in Example 7 for the following conditions:

Hourly Demand on Runway: 52 operations per hour
Hourly Demand on Taxiway Crossing: Not applicable to this example
Hourly Demand on Gates: 19 air carrier operations per hour

Demand Profile Factor on Runway: 40
Demand Profile Factor on Taxiway Crossing: Not applicable to this example
Demand Profile Factor on Gates: 35

Hourly Capacity of Runway: 65 operations per hour
Hourly Capacity of Taxiway: Not applicable to this example
Hourly Capacity of Gates: 33 air carrier operations per hour

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a. Assumes only arrival gate operations are delayed due to influence of gate capacity.

From Example 10 on page 51, the hourly delay to aircraft on the runway is 156 minutes.

For the assumed conditions, the ratio of hourly demand to hourly capacity for the gate component is 19 ÷ 33 = 0.58. As noted in Paragraph 27.b.(5) on page 54, the delay factor for the gate component is equal to the hourly D/C ratio, or 0.58.

From Figure 2-68 the average delay to aircraft on the gates is 1.0 minutes. Therefore the hourly aircraft delay on the gates is 1.0 x [0.5 x 19] = 10 minutes.

Adding the runway and gate delays, the total hourly delay to aircraft on the airfield is 154 + 10 = 164 minutes.

28. PROCEDURE FOR DETERMINING DAILY DELAY TO AIRCRAFT ON RUNWAYS, TAXIWAYS, GATES, AND AIRFIELD. The following procedures are used for determination of daily delay to aircraft using Figures 2-68 through 2-102, located at the end of this chapter.

The procedures are equally appropriate for determination of delay to aircraft for time perids of from two hours up to a day.

a. Comparison of Demand With Capacity. A prerequisite to determining the delay to aircraft in a day (or other shorter time period) is the comparison of the hourly demand to the hourly capacity of each component of the airfield under consideration.

The following procedure is used in this comparison for each component:

(1) Estimate the demand on the component for each hour of the day. Note that the demands on the various components may differ for the same hour.

(2) Determine the hourly capacity of the component for each hour in accordance with procedures in Paragraphs 22 (or Chapter 3), 23, or 24, as appropriate.

(3) Calculate the ratio of hourly demand to hourly capacity (i.e., the hourly D/C ratio) for the component for each hour.

(4) If the hourly D/C ratio does not exceed 1.0 for any hour, estimate the delay to aircraft using the procedure in Paragraph 28.b below.

(5) If the hourly D/C ratio exceeds 1.0 for any hour, estimate the delay to aircraft using the procedure in Paragraph 28.c on page 59.

b. <u>Daily Delay to Aircraft on Runways, Taxiways, and Gates When Demand DOES NOT EXCEED Capacity</u>. If the hourly D/C ratio does not exceed 1.0 for any hour, the following procedure is used to determine the delay to aircraft in a day (or other shorter time period).

For each component of the airfield under consideration:

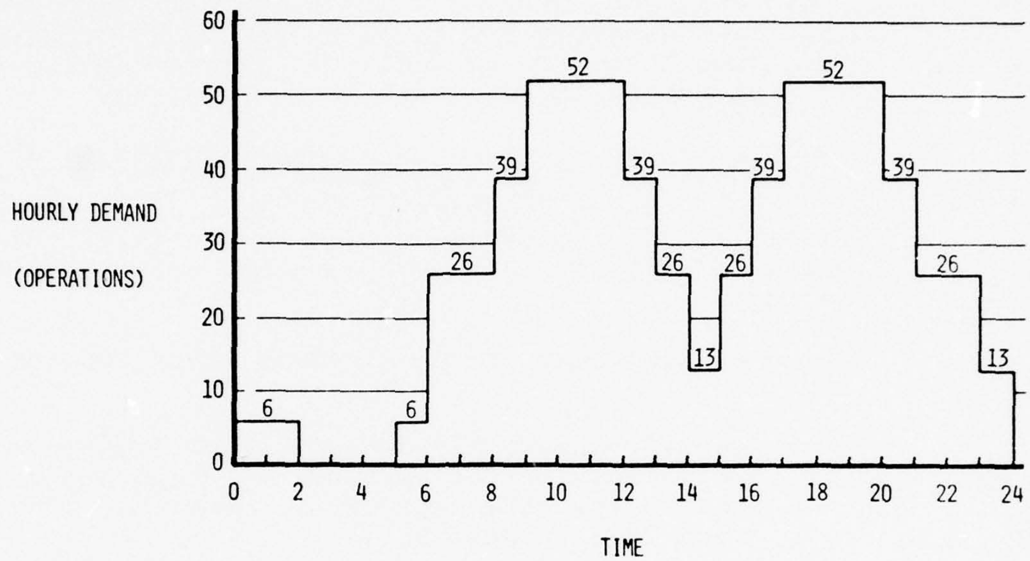
(1) Identify the hourly demands, capacities, and D/C ratios for the appropriate component from the results of the procedure described in Paragraph 28.a on page 56.

(2) Estimate the total hourly delay to aircraft on the component for each hour in accordance with the procedure in Paragraphs 27.a and 27.b on pages 48 and 54.

(3) Determine the daily delay to aircraft on the component by adding the hourly delays to aircraft computed for each hour.

<u>Example 13, Daily Delay to Aircraft on a Single Runway in VFR, Demand DOES NOT EXCEED Capacity</u>.

Assume a single runway accommodates a daily demand in VFR, as illustrated on the next page.



Determine the daily delay to aircraft using the single runway under the following conditions:

Hourly Capacity: 65 operations per hour (i.e., assumed constant for the day)
Aircraft Mix: 35% A, 30% B, 30% C, 5% D
Percent Arrivals: 50%
Demand Profile Factor: 40 (i.e., assumed constant for the day)

From Figure 2-2, select Runway Use Diagram No. 1. The corresponding figure for estimating the arrival and departure indices for delay is 2-70. The mix index is Percent (C+3D) = 30 + 3 x 5 = 45.

For the assumed conditions using Figures 2-70 and 2-68, the daily delay to aircraft is determined as follows. Because of the repetitive nature of daily delay calculations, a tabular format is used in this example.

Hour	Hourly Demand	Hourly Capacity	Hourly D/C Ratio	Arrival Delay Index	Arrival Delay Factor	Departure Delay Index	Departure Delay Factor	Average Hourly Delay to Aircraft Arrivals (minutes)		Total Hourly Delay to Aircraft (minutes)
								Arrivals (minutes)	Departures (Minutes)	
0000 to 0059	6	65	0.09	0.71	0.06	0.53	0.05	0.1	0.1	1[a]
0100 to 0159	6	65	0.09	0.71	0.06	0.53	0.05	0.1	0.1	1
0200 to 0259	0	65	0.00	0.71	0.00	0.53	0.00	0.0	0.0	0
0300 to 0359	0	65	0.00	0.71	0.00	0.53	0.00	0.0	0.0	0
0400 to 0459	0	65	0.00	0.71	0.00	0.53	0.00	0.0	0.0	0
0500 to 0559	6	65	0.09	0.71	0.06	0.53	0.05	0.1	0.1	1
0600 to 0659	26	65	0.40	0.71	0.28	0.53	0.21	0.4	0.3	9
0700 to 0759	26	65	0.40	0.71	0.28	0.53	0.21	0.4	0.3	9
0800 to 0859	39	65	0.60	0.71	0.43	0.61	0.37	0.9	0.7	31
0900 to 0959	52	65	0.80	0.71	0.57	0.75	0.60	1.5	1.7	83
1000 to 1059	52	65	0.80	0.71	0.57	0.75	0.60	1.5	1.7	83
1100 to 1159	52	65	0.80	0.71	0.57	0.75	0.60	1.5	1.7	83
1200 to 1259	39	65	0.60	0.71	0.43	0.61	0.37	0.9	0.7	31
1300 to 1359	26	65	0.40	0.71	0.28	0.53	0.21	0.4	0.3	9
1400 to 1459	13	65	0.20	0.71	0.14	0.53	0.11	0.1	0.3	1
1500 to 1559	26	65	0.40	0.71	0.28	0.53	0.21	0.4	0.3	9
1600 to 1659	39	65	0.60	0.71	0.43	0.61	0.37	0.9	0.7	31
1700 to 1759	52	65	0.80	0.71	0.57	0.75	0.60	1.5	1.7	83
1800 to 1859	52	65	0.80	0.71	0.57	0.75	0.60	1.5	1.7	83
1900 to 1959	52	65	0.80	0.71	0.57	0.75	0.60	1.5	1.7	83
2000 to 2059	39	65	0.60	0.71	0.43	0.61	0.37	0.9	0.7	31
2100 to 2159	26	65	0.40	0.71	0.28	0.53	0.21	0.4	0.3	9
2200 to 2259	26	65	0.40	0.71	0.28	0.53	0.21	0.4	0.3	9
2300 to 2350	13	65	0.20	0.71	0.14	0.53	0.11	0.1	0.1	1
								Total Daily Delay		680

a. $DTH = HD \left\{ [PA \times DAHA] + [(1 - PA) \times DAHD] \right\}$

$= 6 \left\{ [0.50 \times 0.1] + [(1 - 0.5) \times 0.1] \right\} = 1$ min.

Therefore, total daily delay to aircraft = 680 minutes.

c. <u>Daily Delay to Aircraft on Runways, Taxiways, and Gates When Demand EXCEEDS Capacity</u>. If the hourly D/C ratio exceeds 1.0 for any hour, the following procedure is used to determine the delay to aircraft in a day (or other shorter time period).

In this procedure, the hours of the day are divided into groups of one hour or more. These groups are defined as:

- <u>Saturated Periods</u>--one or more consecutive hours when demand exceeds the hourly capacity of the component plus the subsequent hour(s) required to accommodate the residual demand (i.e., demand in the previous hour(s) not yet served).

- Unsaturated Periods--periods other than the saturated periods defined above, consisting of one or more consecutive hours when the demand in each hour does not exceed the hourly capacity of the component.

For each component of the airfield under consideration:

(1) Identify the hourly demands, capacities, and D/C ratios for the appropriate component from the results of the procedure described in Paragraph 28.a on page 56.

(2) Determine the saturated periods and unsaturated periods.

(3) For each saturated period, determine delay to aircraft in accordance with the following steps:

(a) Determine the duration of the "overload phase" (i.e., the number of hours in the saturated period, minus the number of consecutive hours required to accommodate the residual demand).

(b) Calculate the average ratio of hourly demand to hourly capacity (i.e., the average D/C ratio) during the overload phase.

(c) If the taxiway or gate component is under consideration, proceed immediately to Paragraph (i) below.

If the runway component is under consideration, determine the average percent arrivals for the saturated period in accordance with the procedures set forth in Paragraph 21.a.(4) on page 23.

(d) Determine the arrival delay index and the departure delay index for the saturated period from the appropriate figure for delay indicated on Figure 2-2.

(e) Calculate the arrival delay factor, ADF, for the saturated period by the following formula:

$$ADF = ADI \times [AD/C]$$

where,

ADI = arrival delay index

AD/C = average D/C ratio during the overload phase

(f) Calculate the departure delay factor, DDF, for the saturated period by the following formula:

$$DDF = DDI \times [AD/C]$$

where,

DDI = departure delay index

AD/C = average D/C ratio during the overload phase

(g) Estimate the average delay per arrival and departure aircraft for the saturated period from Figure 2-68 or Figure 2-69, as appropriate.

(h) Compute the total delay to aircraft, DTS, on the runway component in the saturated period by the following formula:

$$DTS = \left\{ HD_1 + HD_2 + \ldots + HD_S \right\} \times \left\{ [PAS \times DASA] + [(1 - PAS) \times DASD] \right\}$$

where,

$HD_1, HD_2, \ldots, HD_S$ = hourly demand on the runway component in Hours 1, 2, . . ., S of the saturated period

S = the number of hours in the saturated period

PAS = average percent arrivals for the saturated period ÷ 100

DASA = average delay per arrival aircraft for the saturated period

DASD = average delay per departure aircraft for the saturated period

(i) If the runway component is under consideration, proceed immediately to Paragraph (4) below.

If the taxiway or gate component is under consideration, the delay factor is equal to the average D/C ratio.

(j) Estimate the average delay per aircraft for the saturated period from Figure 2-69.

(k) Compute the total delay to aircraft, DTS, on the taxiway or gate component in the saturated period by the following formula:

$$DTS = [HD_1 + HD_2 + \ldots + HD_S] \times DAS$$

where,

$HD_1, HD_2, \ldots, HD_S$ = hourly demand on the taxiway component or one-half the hourly demand on the gate component in Hours 1, 2, . . ., S of the saturated period.

S = the number of hours in the saturated period.

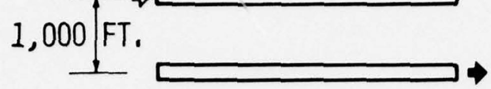
DAS = average delay per aircraft for the saturated period.

(4) For each unsaturated period, determine delay to aircraft in accordance with the procedure in Paragraph 28.b on page 57.

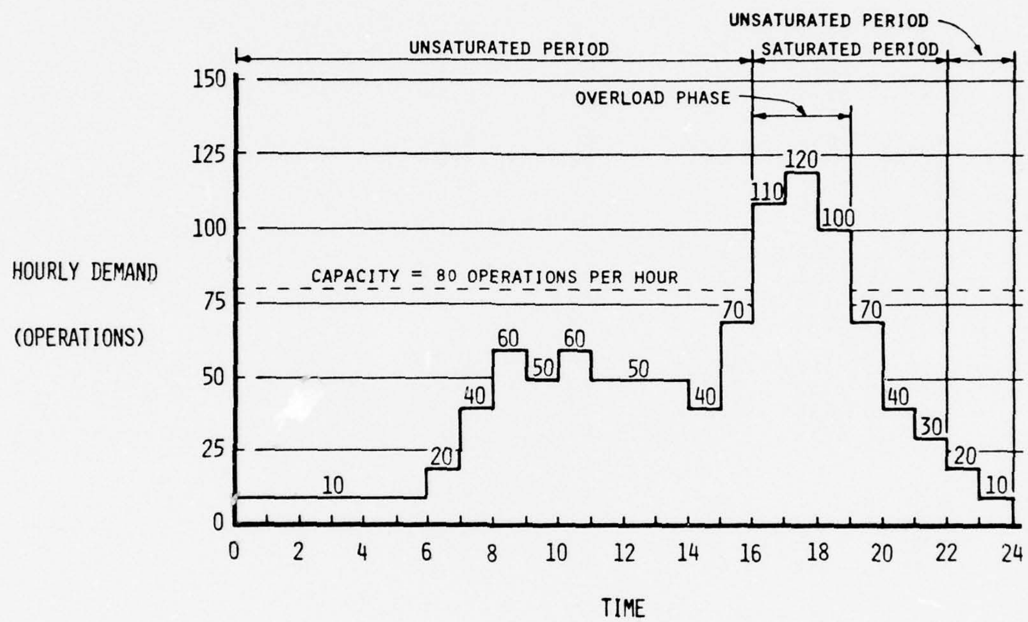
(5) Determine the daily delay to aircraft by adding the total delays computed for the unsaturated period(s) and the saturated period(s).

Example 14, Daily Delay to Aircraft on Two Parallel Runways in VFR, Demand Exceeds Capacity

Assume two parallel runways accommodate a daily demand, as illustrated on the following page.



RUNWAY USE



DAILY DEMAND

Determine the total daily delay to aircraft using the runways under the following conditions:

Hourly Capacity: 80 operations per hour (i.e., assumed constant for the day)
Aircraft Mix: 10% A, 30% B, 50% C, and 10% D (i.e., assumed constant for the day)
Percent Arrivals: 50% (i.e., assumed constant for the day)
Demand Profile Factor: 30 (i.e., assumed constant for the day)

From the illustration, for the assumed hourly demands and capacities, the overload phase is identified as the period from 1600 hours to 1859 hours.

The duration of the unsaturated and saturated periods are determined using the assumed hourly demands, capacities, and D/C ratios as follows:

Hour	Time	Hourly Demand	Hourly Capacity	Hourly D/C Ratio	Residual Demand in Hour		Residual Demand Accommodated in Hour	
1	0000 to 0059	10	80	0.13	0		0	
2	0100 to 0159	10	80	0.13	0		0	
3	0200 to 0259	10	80	0.13	0		0	
4	0300 to 0359	10	80	0.13	0		0	
5	0400 to 0459	10	80	0.13	0		0	
6	0500 to 0559	10	80	0.13	0		0	
7	0600 to 0659	20	80	0.25	0		0	
8	0700 to 0759	40	80	0.50	0		0	
9	0800 to 0859	60	80	0.75	0		0	
10	0900 to 0959	50	80	0.63	0		0	
11	1000 to 1059	60	80	0.75	0		0	
12	1100 to 1159	50	80	0.63	0		0	
13	1200 to 1259	50	80	0.63	0		0	
14	1300 to 1359	50	80	0.63	0		0	
15	1400 to 1459	40	80	0.50	0		0	
16	1500 to 1559	70	80	0.88	0		0	
17	1600 to 1659	110	80	1.38*	30		0	Over-load Phase; Saturated Period
18	1700 to 1759	120	80	1.38*	40		0	
19	1800 to 1859	100	80	1.38*	20		0	
20	1900 to 1959	70	80	0.88	0	90 →	10	
21	2000 to 2059	40	80	0.50	0		40	
22	2100 to 2159	30	80	0.38	0		40	
23	2200 to 2259	20	80	0.25	0		0	
24	2300 to 2359	10	80	0.13	0		0	

*The average D/C ratio during the overload phase = $\frac{110+120+100}{80+80+80} = 1.38$

During the overload phase, the hourly demand exceeds capacity by 30 operations between 1600 and 1659 hours; by 40 operations between 1700 and 1759 hours; and by 20 operations between 1800 and 1859 hours. Thus, a total residual demand of 30 + 40 + 20 = .90 operations must be accommodated in the subsequent hours.

In the next hour (i.e., 1900 to 1959 hours), the demand is 70 operations, or 10 operations less than the hourly capacity (i.e., 80 operations per hour); therefore, it is assumed that 10 operations of the total residual demand of 90 operations are accommodated in this hour, leaving 90 - 10 = 80 residual operations to be accommodated in ensuing hours.

Similarly, between 2000 and 2059 hours, the demand is 40 operations, or 40 operations less than the hourly capacity; as a result, it is assumed that 40 of the remaining 80 residual operations can be accommodated in this particular hour. Therefore, 80 - 40 = 40 residual operations that must be accommodated in the ensuing hour.

Finally, between 2100 and 2159 hours, the demand is 30 operations, or 50 operations less than the hourly capacity. Therefore, the remaining 40 residual operations can be accommodated in this hour.

Thus, the saturated period is from 1600 to 2159 hours, and the remaining hours of the day are an unsaturated period.

From Figure 2-2, select Runway Use Diagram No. 2. The corresponding figure for estimating the arrival and departure indices for delay is Figure 2-71. The mix index is Percent (C+3D) = 50 + 3 x 10 = 80.

For the assumed conditions, the average delay to aircraft in each hour of the unsaturated period is determined using Figures 2-71 and 2-68. Because of the repetitive nature of the calculations, the tabular format at the end of this example is used.

Using the average D/C ratio during the overload phase (i.e., 1.38), from Figure 2-71 for the saturated period, the arrival delay index is 1.0 and the departure delay index is 0.58 (as illustrated in the reproduction of Figure 2-71 below).

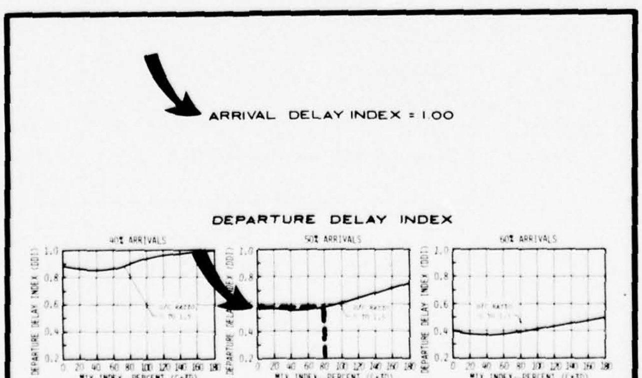


FIGURE 2-71 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 2, 32, 33, 67, 72, 73, 97, 98 FOR VFR CONDITIONS

Thus, for the saturated period, the arrival delay factor is 1.0 x 1.38 = 1.38, and the departure delay factor is 0.58 x 1.38 = 0.80.

For arrival delay per aircraft in the saturated period, the chart on the lower left portion of Figure 2-69 is appropriate because (1) the arrival delay factor during the overload phase (i.e., 1.38) is greater than 1.0, and (2) the duration of the overload phase in this example previously was determined to be three hours. Therefore, from Figure 2-69, the average delay to arrival aircraft in the saturated period is 35.0 minutes (as illustrated in the reproduction of the lower left position of Figure 2-69 below).

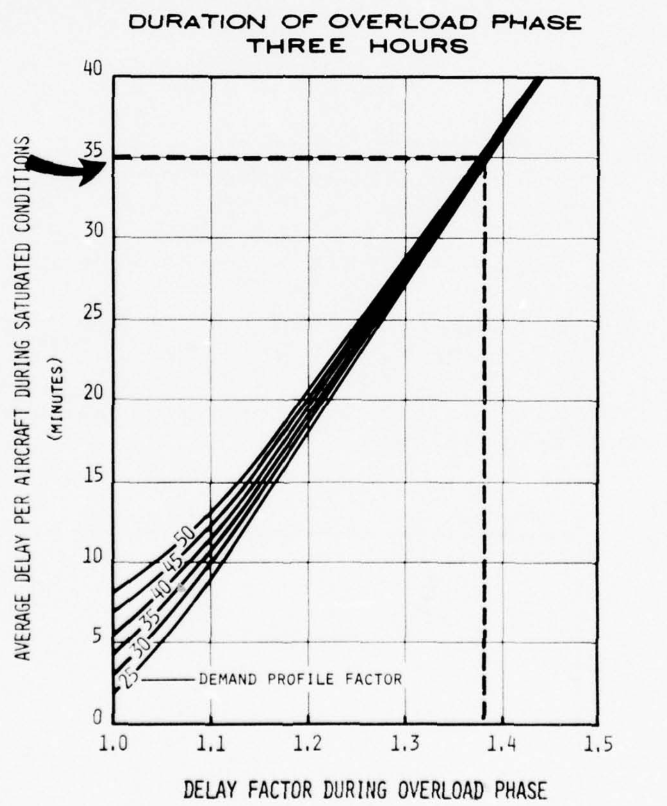


FIGURE 2–69 AVERAGE AIRCRAFT DELAY DUR

For departure delay per aircraft in the saturated period, Figure 2-68 is appropriate because the departure delay factor during the overload phase (i.e., 0.80) is less than 1.0. Therefore, from Figure 2-68, the average delay to departure aircraft in the saturated period is 2.1 minutes (as illustrated in the reproduction of Figure 2-68 below).

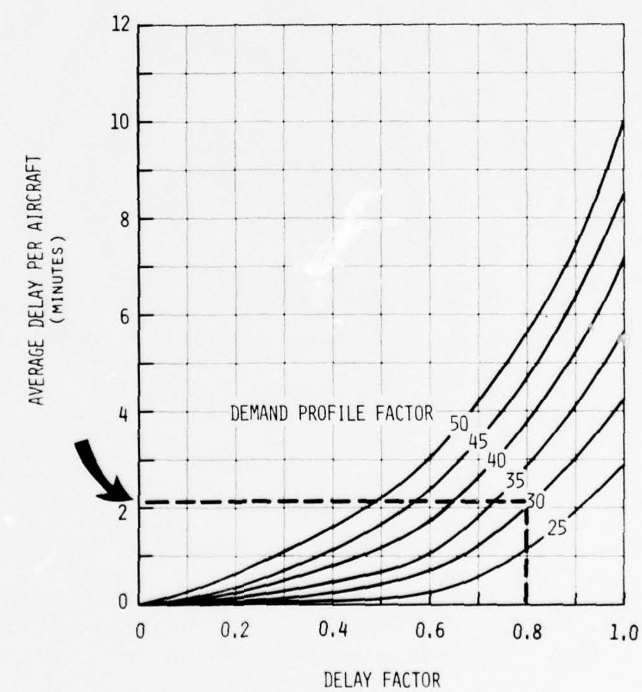


FIGURE 2-68 AVERAGE AIRCRAFT DELAY IN AN HOUR

The total delay to aircraft in the unsaturated period and the saturated period is then determined, as summarized below.

Hour	Hourly Demand	Hourly Capacity	Hourly D/C Ratio	Arrival Delay Index	Arrival Delay Factor	Departure Delay Index	Departure Delay Factor	Average Hourly Delay to Aircraft Arrivals	Average Hourly Delay to Aircraft Departures	Total Hourly Delay to Aircraft
0000 to 0059	10	80	0.13	1.00	0.13	0.58	0.08	0.1	0.1	1
0100 to 0159	10	80	0.13	1.00	0.13	0.58	0.08	0.1	0.1	1
0200 to 0259	10	80	0.13	1.00	0.13	0.58	0.08	0.1	0.1	1
0300 to 0359	10	90	0.13	1.00	0.13	0.58	0.08	0.1	0.1	1
0400 to 0459	10	80	0.13	1.00	0.13	0.58	0.08	0.1	0.1	1
0500 to 0559	10	80	0.13	1.00	0.13	0.58	0.08	0.1	0.1	1
0600 to 0659	20	80	0.25	1.00	0.25	0.58	0.15	0.2	0.1	3
0700 to 0759	40	80	0.50	1.00	0.50	0.58	0.29	0.4	0.2	12
0800 to 0859	60	80	0.75	1.00	0.75	0.58	0.44	1.6	0.3	57
0900 to 0959	50	80	0.63	1.00	0.63	0.58	0.35	0.9	0.2	28
1000 to 1059	60	80	0.75	1.00	0.75	0.58	0.44	1.6	0.3	57
1100 to 1159	50	80	0.63	1.00	0.63	0.58	0.35	0.9	0.2	28
1200 to 1259	50	80	0.63	1.00	0.63	0.58	0.35	0.9	0.2	28
1300 to 1359	50	80	0.63	1.00	0.63	0.58	0.35	0.9	0.2	28
1400 to 1459	40	80	0.50	1.00	0.50	0.58	0.29	0.4	0.2	12
1500 to 1559	70	80	0.88	1.00	0.88	0.58	0.51	2.9	0.4	116
1600 to 1659	110	80								
1700 to 1759	120	80	1.38							
1800 to 1859	100	80								
1900 to 1959	70	80	0.88 →	1.00 →	1.38 →	0.58 →	0.80 →	35.0 →	1.1 →	8,484[a]
2000 to 2059	40	80	0.50							
2100 to 2159	30	80	0.38							
2200 to 2259	20	80	0.25	1.00	0.25	0.58	0.15	0.2	0.1	3
2300 to 2359	10	80	0.13	1.00	0.13	0.58	0.08	0.1	0.1	1
										8,863

a. Total delay to aircraft, DTS, in the saturated period is:

$$\begin{aligned} DTS &= \left\{HD_1 + HD_2 + HD_3 + HD_4 + HD_5 + HD_6\right\} \times \left\{[PAS \times DASA] + [(1 - PAS) \times DASD]\right\} \\ &= \left\{110 + 120 + 100 + 70 + 40 + 30\right\} \times \left\{[0.50 \times 35.0] + [(1 - 0.50) \times 1.1]\right\} \\ &= 8{,}484 \text{ minutes} \end{aligned}$$

- Therefore, total daily delay to aircraft = 8,863 minutes.

d. Daily Delay to Aircraft on the Airfield. To determine the total delay to aircraft on the airfield in a day (or other shorter time period):

(1) Determine the total daily delay to aircraft for each component of the airfield in accordance with Paragraphs 28.a, 28.b, and 28.c, as appropriate.

(2) Determine the total daily delay on the airfield by adding the total daily delays for the runways, taxiways, and gates.

29. PROCEDURE FOR DETERMINING ANNUAL DELAY TO AIRCRAFT ON RUNWAYS, GATES, AND AIRFIELD

The manual procedure for computation of annual delay to aircraft in this chapter can be a very time-consuming task involving a lengthy calculation process. For this reason, the annual delay procedure also is available in computerized format; a tutorial version is included in Chapter 3 and a batch model version is described in Chapter 4. To save time the computerized format is recommended for those who have access to a computer or remote computer terminal. Also, a simplified procedure for obtaining annual delay to aircraft is presented in Appendix 1 for use in preliminary planning when a very approximate estimate of annual delay is all that is needed.

The computation of annual delay to aircraft requires accounting for the seasonal, daily, and hourly variations in demand and capacity throughout the year. Ideally, if the individual hourly demands and hourly capacities are known for each hour in a year, daily delays for each of the 365 days can be computed by the procedures described in Paragraph 28 on page 56. The annual delay is then the sum of the 365 daily delays. Clearly, this ideal approach would require a very large amount of data and time for analysis.

a. Representative Daily Demands. The annual delay procedure in this chapter (and in Chapters 3 and 4), therefore, assumes that the demands in each of the 365 days of the year can be characterized by a much smaller number of representative daily demands. Stated another way, each representative daily demand is typical of a number of days in the year. In the procedure, the daily delay for each representative daily demand is determined, and is then multiplied by the number of days "represented" to determine the total delay associated with each representative daily demand. The annual delay is the sum of the total delay for all representative daily demands.

The number of representative daily demands for a particular airport depends on (1) the variability of daily and hourly demands through the year, and (2) the desired level of refinement in estimating annual delay.

In this chapter, each representative daily demand corresponds to the typical demands in the days of one month. Typically, daily demand may differ in VFR conditions and IFR conditions. Thus, up to 24 representative daily demands are assumed (i.e., one demand in VFR and one demand in IFR for each of the 12 months) in the manual procedure described in this chapter.

b. Annual Delay to Aircraft on Runways and Gates. The following procedure is used in the determination of annual delay to aircraft on runways and gates.

For each component of the airfield under consideration:

(1) Determine each of the representative daily demands as follows:

(a) Determine the annual demand.

(b) Estimate the demand for each month.

(c) Estimate the average daily demand for each month.

(d) Determine the percent of time VFR and IFR conditions occur in each month.

(e) Determine the number of days represented (i.e., the number of days in each month multiplied by the percent of time VFR or IFR conditions occur, as appropriate).

(f) If average daily demand differs in VFR and IFR conditions, determine the representative daily demands for each month by the following formula:

$$DD_V = \frac{DD}{X + (Y \times Z)}$$

$$DD_I = \frac{Z \times DD}{X + (Y \times Z)}$$

where

DD_V = representative daily demand in VFR conditions

DD_I = representative daily demand in IFR conditions

DD = average daily demand

X = percent of time VFR conditions occur in the month ÷ 100

Y = percent of time IFR conditions occur in the month ÷ 100

Z = the ratio of daily demand in IFR conditions to daily demand in VFR conditions

(g) If average daily demand is the same in VFR and IFR conditions, the representative daily demands in VFR and IFR conditions equals the average daily demand.

(h) If IFR conditions do not occur in a particular month, then the representative daily demand in VFR conditions equals the average daily demand and the representative daily demand in IFR conditions equals 0.

(2) For each of the 24 representative daily demands:

(a) Identify the different runway uses under which the airfield component may be used. Do not include those conditions when weather is below landing or takeoff minima.[a]

(b) Determine the percent of time each runway use occurs.[b] Any condition that occurs less than 2% of the time may be ignored if the percent is added to the percent of another condition.

(c) Identify the percent of daily demand occurring in each hour.

---

a. As noted in Paragraph 9.a on page 15, separate analysis of such conditions may be appropriate.

b. Information on the percent of time each runway use occurs during peak periods should be used, if available.

(d) Calculate the demand in each hour of the day, HD, by the following formula:

$$HD = DD \times P$$

where,

DD = representative daily demand

P = percentage of representative daily demand occurring in the particular hour ÷ 100.

(e) Calculate the hourly capacity for each runway use using the procedures presented in Paragraphs 22, 23, or 24, as appropriate. For determining hourly capacity, assume 50% arrivals.

(f) Determine the daily delay for each runway use in accordance with the procedure in Paragraph 28 on page 56 (assuming each runway use occurs for an entire day).

(g) Estimate the daily delay, RD, for each representative daily demand by the following formula:

$$RD = \left(F_1 \times D_1\right) + \left(F_2 \times D_2\right) + \ldots + \left(F_N \times D_N\right)$$

where,

$F_1, F_2, \ldots, F_N$ = the percent of time operations are carried on under Runway Use 1, 2, . . ., N ÷ 100 for the representative daily demand and appropriate ceiling and visibility condition (i.e., VFR or IFR).

$D_1, D_2, \ldots, D_N$ = the daily delay corresponding to Runway Use 1, 2, . . ., N for the representative daily demand and appropriate ceiling and visibility condition (i.e., VFR or IFR).

(3) Estimate the annual delay, AD, on the component by the following formula:

$$AD = \left(D_1 \times RD_1\right) + \left(D_2 \times RD_2\right) + \dots + \left(D_{24} \times RD_{24}\right)$$

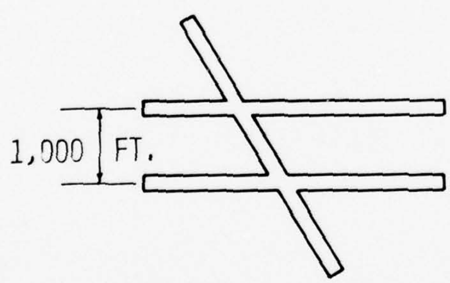
where,

$D_1, D_2, \dots, D_{24}$ = the number of days represented by Representative Daily Demands 1, 2, . . ., 24.

$RD_1, RD_2, \dots, RD_{24}$ = the daily delay associated with Representative Daily Demands 1, 2, . . ., 24.

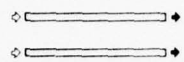
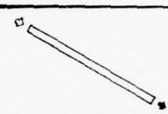
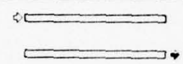
Example 15, Annual Delay to Aircraft

Determine the annual delay to aircraft using the runways illustrated below if the annual demand is 240,000 aircraft operations.



RUNWAY CONFIGURATION

The following operating conditions and hourly capacities are assumed:

Runway Use Case	Runway Use Diagram	Condition	Hourly Capacity[a]
1		VFR	100
2		VFR	54
3		IFR	59

a. Operations per hour, assuming 50% arrivals.

In VFR conditions, Runway Use 1 occurs 95% of the time, and Runway Use 2 occurs 5% of the time. In IFR conditions, Runway Use 3 occurs 100% of the time.

Also assume the following:

Aircraft Mix: 10% A, 20% B, 45% C, and 25% D

Demand Profile Factor: 35

Assume that historical monthly traffic records indicate the following:

Month	Monthly Aircraft Operations	No. of Days in Month	Average Daily Aircraft Operations	Average Daily Aircraft Operations As a Percent of Annual Aircraft Operations
January	9,300	31	300	0.200
February	9,072	28	324	0.216
March	10,788	31	348	0.232
April	11,940	30	398	0.265
May	13,919	31	449	0.299
June	14,940	30	498	0.332
July	16,182	31	522	0.348
August	18,507	31	597	0.398
September	13,410	30	447	0.298
October	12,338	31	398	0.265
November	10,440	30	348	0.232
December	9,300	31	300	0.200
Total Annual Aircraft Operations	150,136			

In addition, from discussions with FAA air traffic control personnel, air traffic activity records and/or analysis of historical weather data from the National Weather Service, assume the ratio of daily demand in IFR conditions to daily demand in VFR conditions is 0.75. Also assume the percent of time VFR or IFR conditions occur and the number of days represented by each daily demand are determined as follows:

Month	No. of Days in Month	Condition	Percent of Time	No. of Days Represented	Month	No. of Days in Month	Condition	Percent of Time	No. of Days Represented
January	31	VFR	85	26.4[a]	July	31	VFR	100	31.0
		IFR	15	4.6			IFR	0	0.0
February	28	VFR	90	25.2	August	31	VFR	100	31.0
		IFR	10	2.8			IFR	0	0.0
March	31	VFR	90	27.9	September	30	VFR	95	28.5
		IFR	10	3.1			IFR	5	1.5
April	30	VFR	90	27.0	October	31	VFR	85	26.4
		IFR	10	3.0			IFR	15	4.6
May	31	VFR	95	29.5	November	30	VFR	85	25.5
		IFR	5	1.5			IFR	15	4.5
June	30	VFR	100	30.0	December	31	VFR	85	26.4
		IFR	0	0.0			IFR	15	4.6

a. 31 x 0.85 = 26.4

Also assume that historical daily traffic records indicate the following typical hourly distribution of daily traffic.

Time	Aircraft Operations	Percent of Daily Aircraft Operations	Time	Aircraft Operations	Percent of Daily Aircraft Operations
0000 to 0059	6	1	1200 to 1259	30	5
0100 to 0159	6	1	1300 to 1359	30	5
0200 to 0259	0	0	1400 to 1459	36	6
0300 to 0359	0	0	1500 to 1559	36	6
0400 to 0459	0	0	1600 to 1659	42	7
0500 to 0559	6	1	1700 to 1759	48	8
0600 to 0659	12	2	1800 to 1859	42	7
0700 to 0759	30	5	1900 to 1959	36	6
0800 to 0859	36	6	2000 to 2059	30	5
0900 to 0959	42	7	2100 to 2159	30	5
1000 to 1059	42	7	2200 to 2259	12	2
1100 to 1159	36	6	2300 to 2359	12	2
			Total	600	100

For the assumed annual demand of 240,000, the average daily demand for the 12 months are estimated from the historical monthly traffic records on page 74, as follows:

Month	Average Daily Aircraft Operations As a Percent of Annual Aircraft Operations	Average Daily Demand[a]	Month	Average Daily Aircraft Operations As a Percent of Annual Aircraft Operations	Average Daily Demand[a]
January	0.200	480	July	0.348	835
February	0.216	518	August	0.398	955
March	0.232	557	September	0.298	715
April	0.265	636	October	0.265	636
May	0.299	718	November	0.232	557
June	0.332	797	December	0.200	480

a. Operations

For the assumed ratio of daily demand in IFR conditions to daily demand in VFR conditions (i.e., 0.75), and the assumed percent occurrence of VFR and IFR conditions in each month, the 24 representative daily demands are determined as follows:

Month	Representative Daily Demand (operations per day)		Month	Representative Daily Demand (operations per day)	
	VFR	IFR		VFR	IFR
January	499[a]	374[b]	July	835	0
February	531	398	August	955	0
March	571	428	September	724	543
April	652	489	October	661	496
May	727	545	November	579	434
June	797	0	December	499	374

a. $DD_V = \frac{DD}{X + (Y \times Z)} = \frac{480}{0.85 + (0.15 \times 0.75)} = 499$

b. $DD_I = \frac{Z \times DD}{X + Y\ (Y \times Z)} = \frac{0.75 \times 480}{0.85 + (0.15 \times 0.75)} = 374$

Based on historical daily traffic records on page 75, the hourly demands for each representative day are calculated. As an example, the following are the resulting hourly demands for the January representative day:

Time	Percent of Daily Aircraft Operations	Hourly Demand[a] VFR	Hourly Demand[a] IFR	Time	Percent of Daily Aircraft Operations	Hourly Demand[a] VFR	Hourly Demand[a] IFR
0000 to 0059	1	5[b]	4[c]	1200 to 1259	5	25	19
0100 to 0159	1	5	4	1300 to 1359	5	25	19
0200 to 0259	0	0	0	1400 to 1459	6	30	22
0300 to 0359	0	0	0	1500 to 1559	6	30	22
0400 to 0459	0	0	0	1600 to 1659	7	35	26
0500 to 0559	1	5	4	1700 to 1759	8	39	29
0600 to 0659	2	10	8	1800 to 1859	7	35	26
0700 to 0759	5	25	19	1900 to 1959	6	30	22
0800 to 0859	6	30	22	2000 to 2059	5	25	19
0900 to 0959	7	35	26	2100 to 2159	5	25	19
1000 to 1059	7	35	26	2200 to 2259	2	10	8
1100 to 1159	6	30	22	2300 to 2359	2	10	8
					Total Daily Demand	499	374

a. Operations
b. 499 x 0.01 = 5
c. 374 x 0.01 = 4

Using the procedure in Paragraph 28 on page 56, the daily delays for each operating condition are determined, and the daily delays for each representative day and annual delay may be estimated as summarized on page 78.

Month	Condition	Case	Runway Use: Percent of Time	Runway Use: Daily Delay (minutes)	Daily Delay for Representative Daily Demand (minutes)	No. of Days Represented	Total Delay (minutes)
January	VFR	1	95	88	94[a]	26.4	2,482[b]
	VFR	2	5	217			
	IFR	3	100	116	116	4.6	534
February	VFR	1	95	104	113	25.2	2,848
	VFR	2	5	280			
	IFR	3	100	143	143	2.8	400
March	VFR	1	95	122	134	27.9	3,739
	VFR	2	5	369			
	IFR	3	100	170	170	3.1	527
April	VFR	1	95	166	192	27.0	5,184
	VFR	2	5	681			
	IFR	3	100	249	249	3.0	747
May	VFR	1	95	226	286	29.5	8,437
	VFR	2	5	1,428			
	IFR	3	100	371	371	1.5	557
June	VFR	1	95	301	436	30.0	13,080
	VFR	2	5	3,002			
	IFR	3	100	544	544	0.0	0
July	VFR	1	95	343	565	31.0	17,515
	VFR	2	5	4,791			
	IFR	3	100	641	641	0.0	0
August	VFR	1	95	521	2,706	31.0	83,886
	VFR	2	5	44,226			
	IFR	3	100	1,083	1,083	0.0	0
September	VFR	1	95	223	282	28.5	8,037
	VFR	2	5	1,393			
	IFR	3	100	365	365	1.5	548
October	VFR	1	95	167	194	26.4	5,122
	VFR	2	5	700			
	IFR	3	100	253	253	4.6	1,164
November	VFR	1	95	122	134	25.5	3,417
	VFR	2	5	369			
	IFR	3	100	170	170	4.5	765
December	VFR	1	95	89	96	26.4	2,534
	VFR	2	5	221			
	IFR	3	100	118	118	4.6	543
						Total Annual Delay	162,066[c]

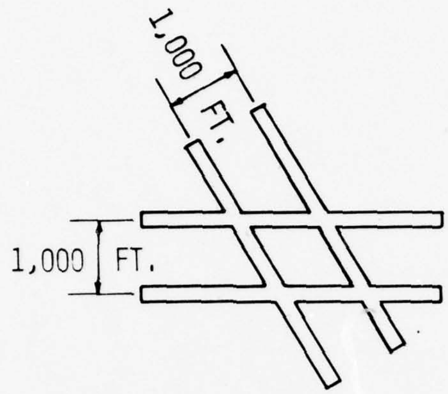
a. $RD = (F_1 \times D_1) + (F_2 \times D_2) = 0.95 \times 88 + 0.05 \times 217 = 94$

b. $D_1 \times RD_1 = 26.4 \times 59 = 2,482$

c. $AD = (D_1 \times RD_1) + (D_2 \times RD_2) + \ldots + (D_{24} \times RD_{24})$

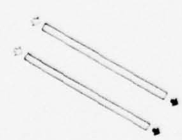
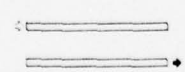
Example 16, Aircraft Delay Savings

Assume that a new parallel runway is added to the airport in Example 15 as illustrated below.



RUNWAY CONFIGURATION

Determine the savings (reduction in delay) on the runway component under the following conditions:

Runway Use Case	Diagram	Condition	Hourly Capacity[a]
1		VFR	100
2		VFR	100
3		IFR	59

a. Operations per hour, assuming 50% arrivals.

Using the same procedures as in Example 15, the annual delay savings to aircraft for the parallel runway use is 162,066 minutes (Example 15) minus 77,373 minutes = 84,693 minutes of aircraft delay

INFORMATION REQUIRED FOR COMPUTATION OF CAPACITY AND DELAY

Outputs	Inputs Needed
1. Hourly capacity of runway(s)	• Ceiling and visibility • Runway use • Aircraft mix • Percent arrivals • Percent touch-and-go • Exit taxiway location
2. Hourly capacity of taxiway crossing an active runway	• Intersecting taxiway location • Runway operations rate • Aircraft mix using runway
3. Hourly capacity of gates	• Number and type of gates in each gate group • Gate mix • Gate occupancy times
4. Hourly capacity of an airfield	• Hourly capacity (Outputs No. 1, 2, and 3)
5. Annual service volume of runways and gates	• Hourly capacities • Occurrence of operating conditions
6. Hourly delay to aircraft on runways, taxiways, gates, and airfield	• Hourly demand • Hourly capacity • Demand profile factor
7. Daily delay to aircraft on runways, taxiways, gates, and airfield	• Hourly delay • Hourly demand • Hourly capacity
8. Annual delay to aircraft on runways, gates, and airfield	• Annual demand • Daily demand • Hourly demand • Hourly capacities • Occurrence of ceiling and visibility conditions and runway use

FIGURE 2-1 CAPACITY AND DELAY INPUTS

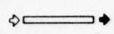
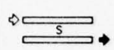
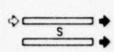
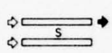
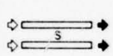
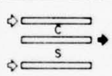
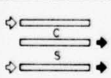
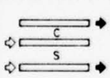
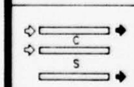
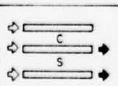
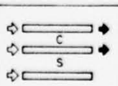
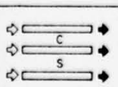
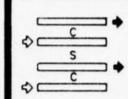
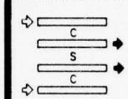
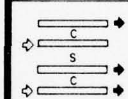
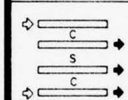
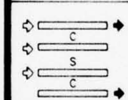
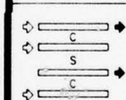
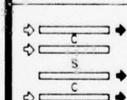
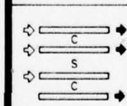
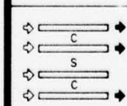
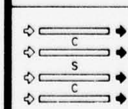
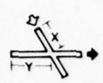
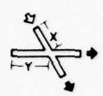
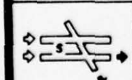
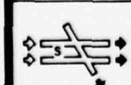
RUNWAY USE DIAGRAM	DIAG. NO.	RUNWAY SPACING[A] IN FEET (S)	FIGURE NO. FOR CAPACITY VFR	FOR CAPACITY IFR	FOR DELAY VFR	FOR DELAY IFR
	1	N.A.	2-3	2-43	2-70	2-89
	2	700[B] OR MORE	2-4	2-44	2-71	2-90
	3	700[B] TO 2499	2-5	2-44	2-72	2-90
	4	2500 TO 3499	2-6	2-44	2-73	2-90
	5	3500 OR MORE	2-6	2-45	2-73	2-91
	6	700[B] TO 2499	2-7	2-44	2-74	2-90
	7	2500 TO 4299	2-8	2-46	2-74	2-92
	8	4300 OR MORE	2-8	2-47	2-74	2-93
	9	700[B] TO 2499	2-9	2-44	2-70	2-90
	10	2500 TO 3499	2-10	2-48	2-70	2-94
	11	3500 TO 4299	2-10	2-49	2-70	2-95
	12	4300 OR MORE	2-10	2-50	2-70	2-96
	13	700 TO 3499	2-11	2-51	2-75	2-97
	14	3500 OR MORE	2-11	2-52	2-75	2-98
	15	700 TO 2499	2-12	2-51	2-76	2-97
	16	2500 TO 3499	2-13	2-51	2-77	2-97
	17	3500 OR MORE	2-13	2-53	2-77	2-99
	18	700 TO 2499	2-14	2-54	2-77	2-100
	19	2500 TO 4299	2-13	2-55	2-77	2-91
	20	4300 OR MORE	2-13	2-53	2-77	2-93
	21	700 TO 2499	2-14	2-54	2-77	2-100
	22	2500 OR MORE	2-14	2-56	2-77	2-101
	23	700 TO 2499	2-15	2-51	2-78	2-97
	24	2500 TO 3499	2-16	2-51	2-79	2-97
	25	3500 OR MORE	2-16	2-53	2-78	2-99
	26	700 TO 2499	2-15	2-51	2-78	2-97
	27	2500 TO 3499	2-17	2-51	2-79	2-97
	28	3500 OR MORE	2-17	2-52	2-79	2-98
	29	700 TO 2499	2-18	2-48	2-80	2-94
	30	2500 TO 3499	2-19	2-55	2-70	2-91
	31	3500 OR MORE	2-19	2-53	2-70	2-99
	32	3500 OR MORE	2-20	2-57	2-71	2-90
	33	3500 OR MORE	2-20	2-57	2-71	2-90
	34	3500 OR MORE	2-21	2-57	2-81	2-90
	35	3500 OR MORE	2-21	2-57	2-81	2-90
	36	3500 TO 4299	2-22	2-53	2-82	2-99
	37	4300 OR MORE	2-22	2-57	2-82	2-90
	38	3500 OR MORE	2-22	2-57	2-82	2-90
	39	3500 OR MORE	2-23	2-57	2-83	2-90
	40	3500 OR MORE	2-24	2-57	2-83	2-90
	41	3500 OR MORE	2-25	2-57	2-79	2-90
	42	3500 OR MORE	2-26	2-57	2-70	2-90

FIGURE 2–2 RUNWAY USES

RUNWAY USE DIAGRAM	DIAG. NO.	RUNWAY INTERSECTION DISTANCE IN FEET (X)	(Y)	FIGURE NO. FOR CAPACITY VFR	FOR CAPACITY IFR	FOR DELAY VFR	FOR DELAY IFR
	43	0 TO 1999	< 4000	2-27	2-58	2-84	2-90
	44	2000 TO 4999	< 4000	2-28	2-59	2-85	2-99
	45	5000 TO 8000	< 4000	2-29	2-60	2-85	2-99
	46	0 TO 1999	≥ 4000	2-30	2-61	2-85	2-99
	47	2000 TO 4999	≥ 4000	2-31	2-62	2-70	2-102
	48	5000 TO 8000	≥ 4000	2-32	2-63	2-70	2-102
	49	0 TO 1999	< 4000	2-27	2-58	2-84	2-90
	50	2000 TO 4999	< 4000	2-28	2-59	2-85	2-99
	51	5000 TO 8000	< 4000	2-29	2-60	2-85	2-99
	52	0 TO 1999	≥ 4000	2-30	2-61	2-85	2-99
	53	2000 TO 4999	≥ 4000	2-31	2-64	2-70	2-89
	54	5000 TO 8000	≥ 4000	2-3	2-43	2-70	2-89
	55	0 TO 1999	< 4000	2-33	2-58	2-84	2-90
	56	2000 TO 4999	< 4000	2-34	2-59	2-85	2-99
	57	5000 TO 8000	< 4000	2-35	2-60	2-85	2-99
	58	0 TO 1999	≥ 4000	2-36	2-61	2-85	2-99
	59	2000 TO 4999	≥ 4000	2-37	2-62	2-86	2-102
	60	5000 TO 8000	≥ 4000	2-38	2-63	2-86	2-102
	61	0 TO 1999	< 4000	2-33	2-44	2-84	2-90
	62	2000 TO 4999	< 4000	2-39	2-44	2-85	2-90
	63	5000 TO 8000	< 4000	2-35	2-44	2-85	2-90
	64	0 TO 1999	≥ 4000	2-36	2-44	2-85	2-90
	65	2000 TO 4999	≥ 4000	2-37	2-44	2-86	2-90
	66	5000 TO 8000	≥ 4000	2-9	2-44	2-70	2-90

RUNWAY USE DIAGRAM	DIAG. NO.	RUNWAY SPACING[A] IN FEET (S)	FIGURE NO. FOR CAPACITY VFR	FOR CAPACITY IFR	FOR DELAY VFR	FOR DELAY IFR
	67	700 OR MORE	2-4	2-44	2-71	2-90
	68	700 TO 2499	2-9	2-44	2-70	2-90
	69	2500 TO 3499	2-10	2-48	2-70	2-94
	70	3500 TO 4299	2-10	2-49	2-70	2-95
	71	4300 OR MORE	2-10	2-50	2-70	2-96

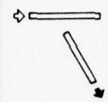
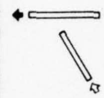
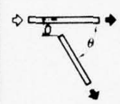
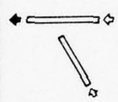
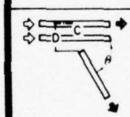
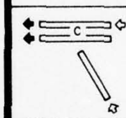
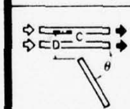
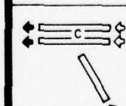
RUNWAY USE DIAGRAM	DIAG. NO.	ANGLE (θ°)	RUNWAY SEPARATION IN FEET (D)	FIGURE NO. FOR CAPACITY VFR	FOR CAPACITY IFR	FOR DELAY VFR	FOR DELAY IFR
	72	N.A.	N.A.	2-4	2-44	2-71	2-90
	73	N.A.	N.A.	2-4	2-44	2-71	2-90
	74	0-14	< 3500	2-6	2-44	2-73	2-90
	75	0-14	≥ 3500	2-6	2-45	2-73	2-91
	76	15-29	< 2000	2-6	2-44	2-73	2-90
	77	15-29	≥ 2000	2-6	2-45	2-73	2-91
	78	> 30	N.A.	2-6	2-45	2-73	2-91
	79	N.A.	N.A.	2-8	2-44	2-74	2-90
	80	0-14	< 3500	2-14	2-54	2-77	2-100
	81	0-14	≥ 3500	2-14	2-56	2-77	2-101
	82	15-29	< 2000	2-14	2-54	2-77	2-100
	83	15-29	≥ 2000	2-14	2-56	2-77	2-101
	84	> 30	N.A.	2-14	2-56	2-77	2-101
	85	N.A.	N.A.	2-12	2-44	2-76	2-90
	86	0-14	< 3500	2-40	2-54	2-87	2-100
	87	0-14	≥ 3500	2-40	2-56	2-87	2-101
	88	15-29	< 2000	2-40	2-54	2-87	2-100
	89	15-29	≥ 2000	2-40	2-56	2-87	2-101
	90	> 30	N.A.	2-40	2-56	2-87	2-101
	91	N.A.	N.A.	2-17	2-44	2-79	2-90

FIGURE 2-2 RUNWAY USES (CONTINUED)

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TECHNIQUES FOR DETERMINING AIRPORT AIRSIDE CAPACITY AND DELAY.(U)

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2 OF 3

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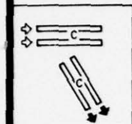
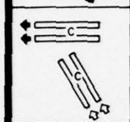
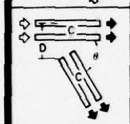
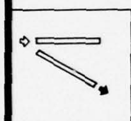
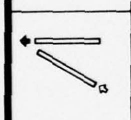
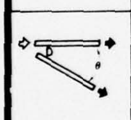
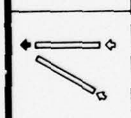
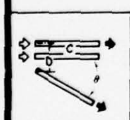
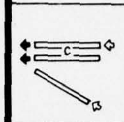
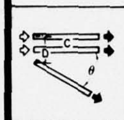
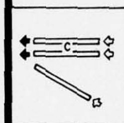
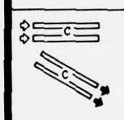
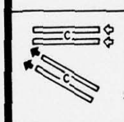
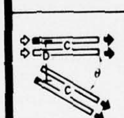
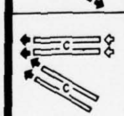
RUNWAY USE DIAGRAM	DIAG. NO.	ANGLE ($\theta°$)	RUNWAY SEPARATION IN FEET (D)	FIGURE NO. FOR CAPACITY VFR	FOR CAPACITY IFR	FOR DELAY VFR	FOR DELAY IFR
	92	N.A.	N.A.	2-41	2-44	2-88	2-90
	93	N.A.	N.A.	2-41	2-44	2-88	2-90
	94	0-14	< 3500	2-42	2-54	2-73	2-100
	95	0-14	≥ 3500	2-42	2-56	2-73	2-101
	96	≥ 15	N.A.	2-42	2-56	2-73	2-101
	97	N.A.	N.A.	2-4	2-44	2-71	2-90
	98	N.A.	N.A.	2-4	2-44	2-71	2-90
	99	0-14	< 3500	2-6	2-44	2-73	2-90
	100	0-14	≥ 3500	2-6	2-45	2-73	2-91
	101	15-29	< 2000	2-6	2-44	2-73	2-90
	102	15-29	≥ 2000	2-6	2-45	2-73	2-91
	103	≥ 30	N.A.	2-6	2-45	2-73	2-91
	104	N.A.	N.A.	2-8	2-44	2-74	2-90
	105	0-14	< 3500	2-14	2-54	2-77	2-100
	106	0-14	≥ 3500	2-14	2-56	2-77	2-101
	107	15-29	< 2000	2-14	2-54	2-77	2-100
	108	15-29	≥ 2000	2-14	2-56	2-77	2-101
	109	≥ 30	N.A.	2-14	2-56	2-77	2-101

RUNWAY USE DIAGRAM	DIAG. NO.	ANGLE ($\theta°$)	RUNWAY SEPARATION IN FEET (D)	FIGURE NO. FOR CAPACITY VFR	FOR CAPACITY IFR	FOR DELAY VFR	FOR DELAY IFR
	110	N.A.	N.A.	2-12	2-44	2-76	2-90
	111	0-14	< 3500	2-40	2-54	2-87	2-100
	112	0-14	≥ 3500	2-40	2-56	2-87	2-101
	113	15-29	< 2000	2-40	2-54	2-87	2-100
	114	15-29	≥ 2000	2-40	2-56	2-87	2-101
	115	> 30	N.A.	2-40	2-56	2-87	2-101
	116	N.A.	N.A.	2-17	2-44	2-79	2-90
	117	N.A.	N.A.	2-41	2-44	2-88	2-90
	118	N.A.	N.A.	2-41	2-44	2-88	2-90
	119	0-14	< 3500	2-42	2-54	2-73	2-100
	120	0-14	≥ 3500	2-42	2-56	2-73	2-101
	121	≥15	N.A.	2-42	2-56	2-73	2-101
	122	N.A.	N.A.	2-41	2-44	2-88	2-90

LEGEND:

⇨ Indicates that an arrival (or landing) can occur on the runway indicated.

➡ Indicates that a departure (or takeoff) can occur on the runway indicated.

The lack of a symbol means that aircraft operations will not occur from the runway indicated.

S Indicates a variable runway spacing.

C Indicates runway spacing category 700 to 2499 feet.

D Indicates runway separation in feet.

X, Y Indicates intersection distances.

$\theta°$ Indicates the angle between nonparallel runways.

N.A. Not applicable.

< Indicates "less than".

≥ Indicates "greater than or equal to".

For those cases in which the majority of aircraft are restricted from using one or more runways, see Appendix 5.

For footnotes A and B see next page of this handbook.

FIGURE 2–2 RUNWAY USES (CONTINUED)

Figure 2-2 (cont.)

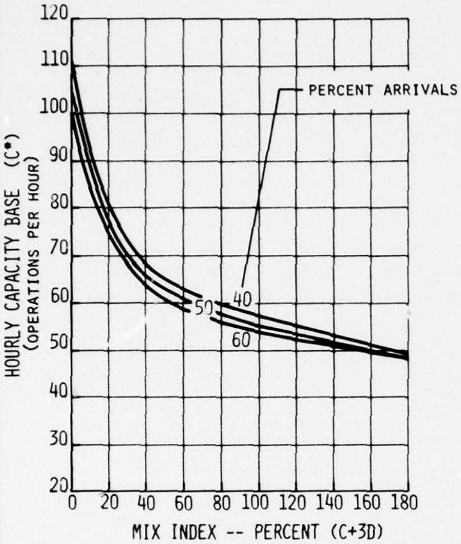
Footnote A:

Minimum Centerline Spacing: The minimum centerline spacing is 700 feet for simultaneous operations on parallel runways used by all aircraft classes. Minimum spacing is reduced to 500 feet for parallel runways used by Class B and Class A aircraft and to 300 feet for parallel runways used by Class A aircraft only. If the spacing is less than these minimums, the two runways should be considered as a single runway.

Footnote B:

Dual Lane Runways: In accordance with definition in Dual Lane Runway Study, Report No. FAA-RD-74-80, May 1974.

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR **T**

Percent Touch & Go	Mix Index-- Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.04
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.20
31 to 40	0 to 10	1.31
41 to 50	0 to 10	1.40

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

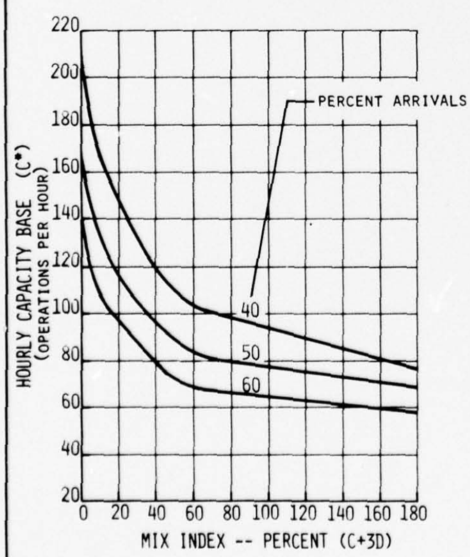
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.72	0.87	0.94	0.70	0.86	0.94	0.67	0.84	0.92
21 to 50	3000 to 5500	0.79	0.86	0.94	0.76	0.84	0.93	0.72	0.81	0.90
51 to 80	3500 to 6500	0.79	0.86	0.92	0.76	0.83	0.91	0.73	0.81	0.90
81 to 120	5000 to 7000	0.82	0.89	0.93	0.80	0.88	0.94	0.77	0.86	0.93
121 to 180	5500 to 7500	0.86	0.94	0.98	0.82	0.91	0.96	0.79	0.91	0.97

FIGURE 2–3 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 1, 54 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR **T**

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

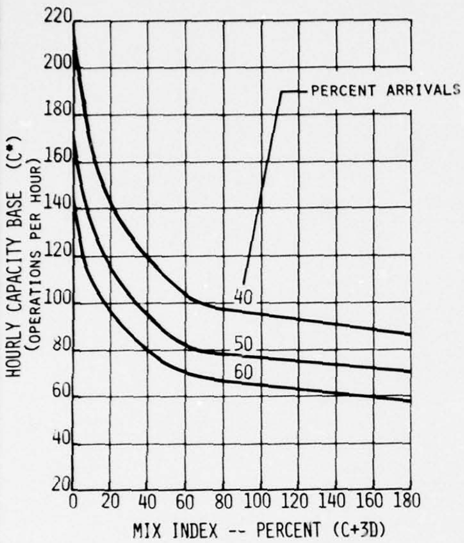
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.62	0.79	0.90	0.62	0.79	0.90	0.62	0.79	0.90
21 to 50	3000 to 5500	0.72	0.83	0.93	0.72	0.83	0.93	0.72	0.83	0.93
51 to 80	3500 to 6500	0.75	0.84	0.92	0.75	0.84	0.92	0.75	0.84	0.92
81 to 120	5000 to 7000	0.80	0.87	0.94	0.80	0.87	0.94	0.80	0.87	0.94
121 to 180	5500 to 7500	0.94	1.00	1.00	0.83	0.93	0.97	0.83	0.93	0.97

FIGURE 2–4 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 2, 67, 72, 73, 97, 98 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index-- Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.05
21 to 30	0 to 40	1.09
31 to 40	0 to 10	1.15
41 to 50	0 to 10	1.20

C* x T x E = Hourly Capacity

EXIT FACTOR E

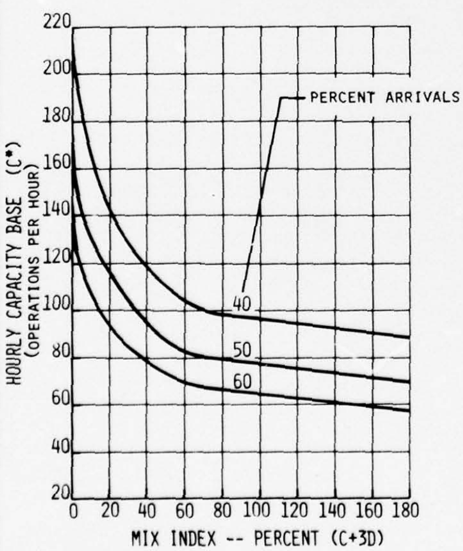
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.62	0.79	0.90	0.62	0.79	0.90	0.62	0.79	0.90
21 to 50	3000 to 5500	0.72	0.83	0.93	0.72	0.83	0.93	0.72	0.83	0.93
51 to 80	3500 to 6500	0.75	0.84	0.92	0.75	0.84	0.92	0.75	0.84	0.92
81 to 120	5000 to 7000	0.80	0.87	0.94	0.80	0.87	0.94	0.80	0.87	0.94
121 to 180	5500 to 7500	0.85	0.96	0.98	0.83	0.93	0.97	0.83	0.93	0.97

FIGURE 2–5 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 3 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index-- Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.02
11 to 20	0 to 70	1.04
21 to 30	0 to 40	1.08
31 to 40	0 to 10	1.13
41 to 50	0 to 10	1.17

C* x T x E = Hourly Capacity

EXIT FACTOR E

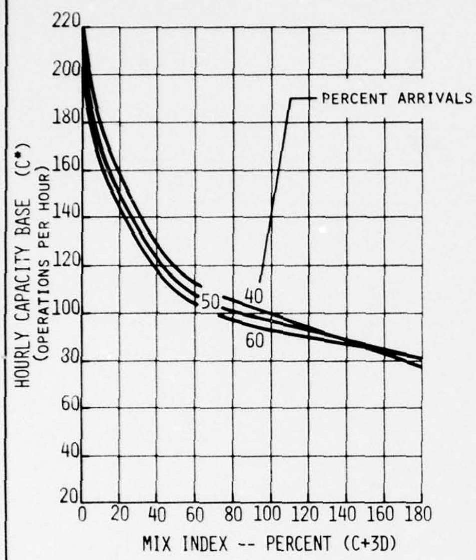
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.62	0.79	0.90	0.62	0.79	0.90	0.62	0.79	0.90
21 to 50	3000 to 5500	0.72	0.83	0.93	0.72	0.83	0.93	0.72	0.83	0.93
51 to 80	3500 to 6500	0.75	0.84	0.92	0.75	0.84	0.92	0.75	0.84	0.92
81 to 120	5000 to 7000	0.80	0.87	0.94	0.80	0.87	0.94	0.80	0.87	0.94
121 to 180	5500 to 7500	0.83	0.93	0.97	0.83	0.93	0.97	0.83	0.93	0.97

FIGURE 2–6 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 4, 5, 74, 75, 76, 77, 78, 99, 100, 101, 102, 103, FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR **T**

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.02
11 to 20	0 to 70	1.05
21 to 30	0 to 40	1.08
31 to 40	0 to 10	1.11
41 to 50	0 to 10	1.14

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

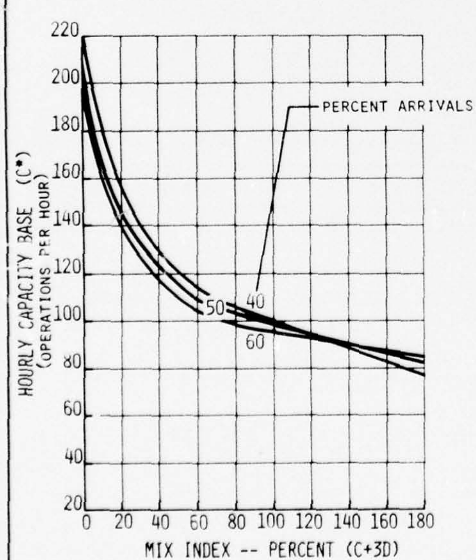
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. *If N is 4 or more, Exit Factor = 1.00*
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.75	0.88	0.94	0.72	0.86	0.94	0.69	0.84	0.93
21 to 50	3000 to 5500	0.83	0.91	0.97	0.80	0.89	0.96	0.77	0.86	0.94
51 to 80	3500 to 6500	0.85	0.91	0.96	0.82	0.89	0.95	0.79	0.87	0.93
81 to 120	5000 to 7000	0.89	0.93	0.97	0.87	0.91	0.96	0.84	0.89	0.95
121 to 180	5500 to 7500	0.97	1.00	1.00	0.91	0.97	0.99	0.90	0.96	0.98

FIGURE 2–7 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 6 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR **T**

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.02
11 to 20	0 to 70	1.05
21 to 30	0 to 40	1.08
31 to 40	0 to 10	1.11
41 to 50	0 to 10	1.14

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

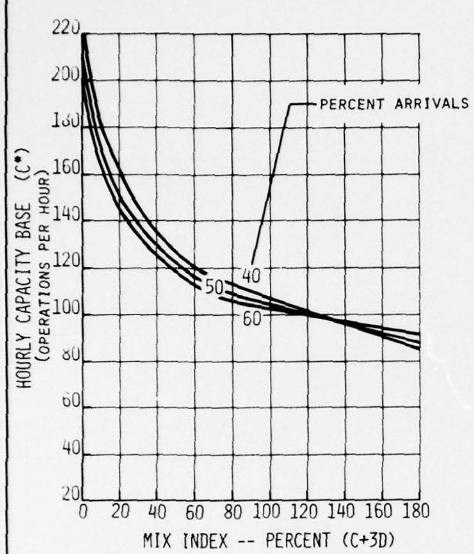
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.75	0.88	0.94	0.72	0.86	0.94	0.69	0.84	0.93
21 to 50	3000 to 5500	0.83	0.91	0.97	0.81	0.89	0.96	0.78	0.87	0.95
51 to 80	3500 to 6500	0.85	0.91	0.95	0.82	0.89	0.94	0.80	0.88	0.94
81 to 120	5000 to 7000	0.89	0.93	0.96	0.87	0.91	0.96	0.84	0.90	0.95
121 to 180	5500 to 7500	0.97	1.00	1.00	0.90	0.96	0.98	0.88	0.95	0.98

FIGURE 2–8 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 7, 8, 79, 104 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.04
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.20
31 to 40	0 to 10	1.31
41 to 50	0 to 10	1.40

C* x T x E = Hourly Capacity

EXIT FACTOR E

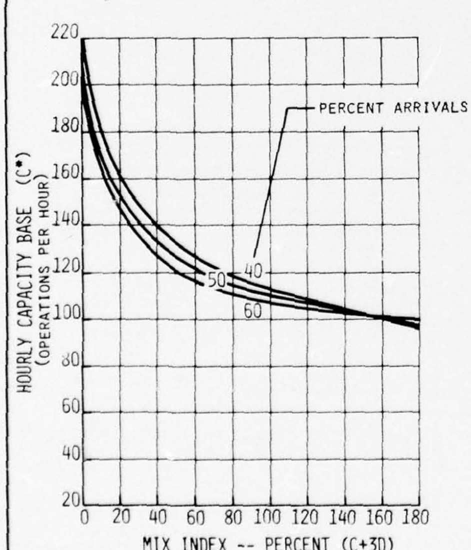
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.72	0.87	0.94	0.70	0.86	0.94	0.67	0.84	0.92
21 to 50	3000 to 5500	0.79	0.86	0.94	0.76	0.84	0.93	0.72	0.81	0.90
51 to 80	3500 to 6500	0.79	0.86	0.92	0.76	0.83	0.91	0.73	0.81	0.90
81 to 120	5000 to 7000	0.83	0.89	0.93	0.80	0.87	0.94	0.77	0.86	0.93
121 to 180	5500 to 7500	0.85	0.93	0.98	0.81	0.91	0.97	0.78	0.89	0.97

FIGURE 2-9 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 9, 66, 68 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.04
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.20
31 to 40	0 to 10	1.31
41 to 50	0 to 10	1.40

C* x T x E = Hourly Capacity

EXIT FACTOR E

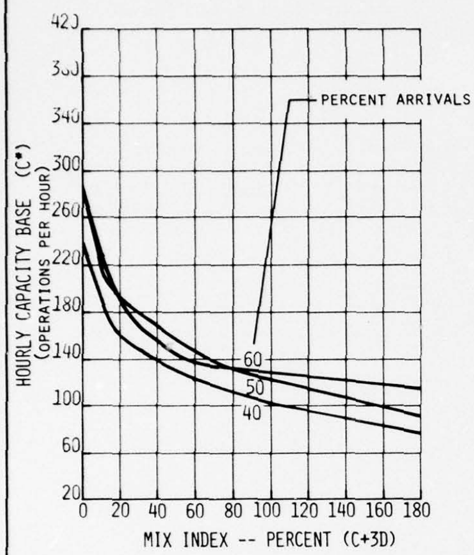
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.72	0.87	0.94	0.70	0.86	0.94	0.67	0.84	0.92
21 to 50	3000 to 5500	0.79	0.86	0.94	0.76	0.84	0.93	0.72	0.81	0.90
51 to 80	3500 to 6500	0.79	0.86	0.92	0.76	0.83	0.91	0.73	0.81	0.90
81 to 120	5000 to 7000	0.82	0.89	0.93	0.80	0.88	0.94	0.77	0.86	0.93
121 to 180	5500 to 7500	0.86	0.94	0.98	0.82	0.91	0.96	0.79	0.91	0.97

FIGURE 2-10 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 10, 11, 12, 69, 70, 71 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

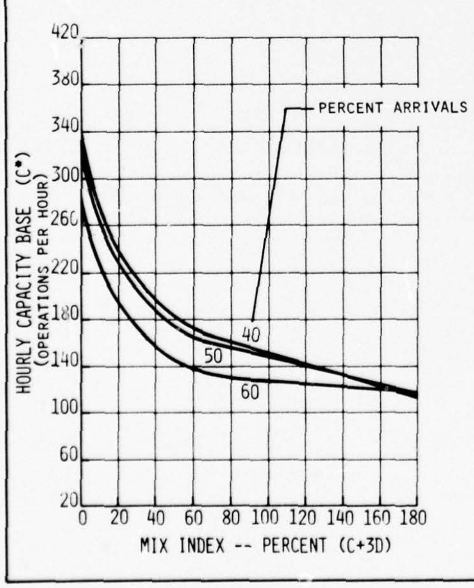
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. *If N is 4 or more, Exit Factor = 1.00*
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	1.00	1.00	1.00	0.73	0.93	1.00	0.62	0.79	0.90
21 to 50	3000 to 5500	1.00	1.00	1.00	0.82	0.95	1.00	0.72	0.83	0.93
51 to 80	3500 to 6500	1.00	1.00	1.00	0.84	0.94	1.00	0.75	0.84	0.92
81 to 120	5000 to 7000	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.87	0.94
121 to 180	5500 to 7500	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.93	0.98

FIGURE 2–11 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 13, 14 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.05
21 to 30	0 to 40	1.11
31 to 40	0 to 10	1.20
41 to 50	0 to 10	1.26

C* x T x E = Hourly Capacity

EXIT FACTOR E

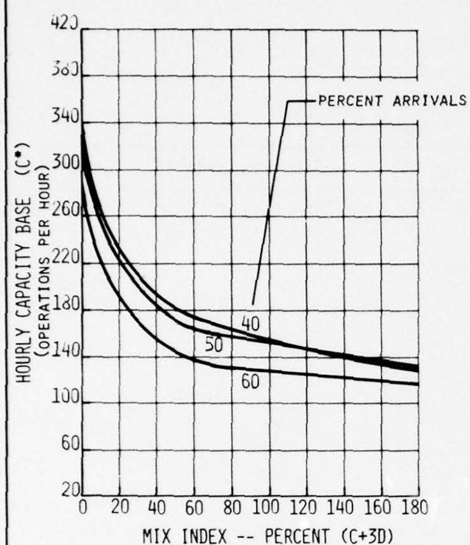
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.76	0.88	0.94	0.65	0.83	0.93	0.62	0.79	0.90
21 to 50	3000 to 5500	0.83	0.90	0.96	0.72	0.83	0.94	0.72	0.83	0.93
51 to 80	3500 to 6500	0.85	0.91	0.96	0.75	0.84	0.92	0.75	0.84	0.92
81 to 120	5000 to 7000	0.90	0.94	0.97	0.82	0.88	0.95	0.80	0.87	0.94
121 to 180	5500 to 7500	0.93	0.98	1.00	0.90	0.97	0.99	0.86	0.95	0.98

FIGURE 2–12 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 15, 85, 110 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.05
21 to 30	0 to 40	1.11
31 to 40	0 to 10	1.20
41 to 50	0 to 10	1.26

C* x T x E = Hourly Capacity

EXIT FACTOR E

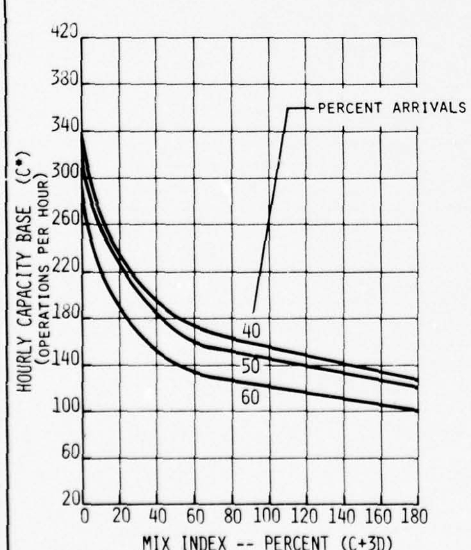
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.76	0.88	0.94	0.65	0.83	0.93	0.62	0.79	0.90
21 to 50	3000 to 5500	0.83	0.90	0.96	0.72	0.83	0.94	0.72	0.83	0.93
51 to 80	3500 to 6500	0.85	0.91	0.96	0.75	0.84	0.92	0.75	0.84	0.92
81 to 120	5000 to 7000	0.90	0.94	0.97	0.82	0.88	0.95	0.80	0.87	0.94
121 to 180	5500 to 7500	0.93	0.98	1.00	0.90	0.97	0.99	0.86	0.95	0.98

FIGURE 2–13 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 16, 17, 19, 20 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.05
21 to 30	0 to 40	1.11
31 to 40	0 to 10	1.20
41 to 50	0 to 10	1.26

C* x T x E = Hourly Capacity

EXIT FACTOR E

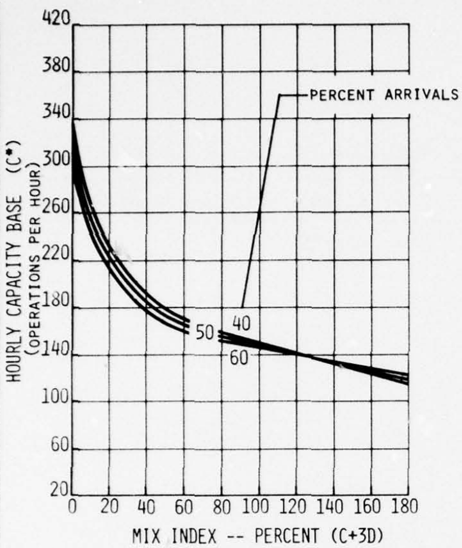
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.76	0.88	0.94	0.65	0.83	0.93	0.62	0.79	0.90
21 to 50	3000 to 5500	0.83	0.90	0.96	0.72	0.83	0.94	0.72	0.83	0.93
51 to 80	3500 to 6500	0.85	0.91	0.96	0.75	0.84	0.92	0.75	0.84	0.92
81 to 120	5000 to 7000	0.90	0.94	0.97	0.82	0.88	0.95	0.80	0.87	0.94
121 to 180	5500 to 7500	0.93	0.98	1.00	0.90	0.97	0.99	0.86	0.95	0.98

FIGURE 2–14 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 18, 21, 22, 80, 81, 82, 83, 84, 105, 106, 107, 108, 109 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.01
11 to 20	0 to 70	1.02
21 to 30	0 to 40	1.03
31 to 40	0 to 10	1.04
41 to 50	0 to 10	1.05

C* x T x E = Hourly Capacity

EXIT FACTOR E

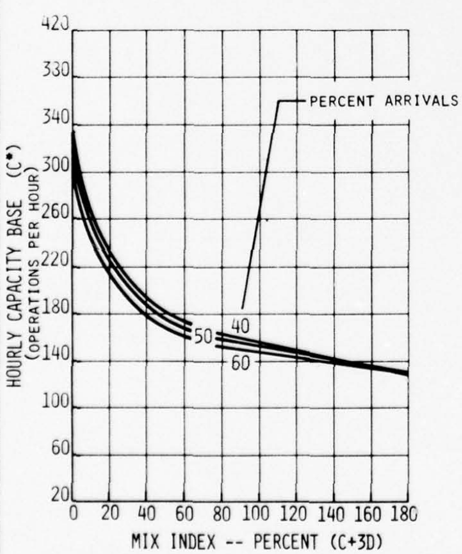
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.75	0.88	0.94	0.72	0.86	0.93	0.69	0.84	0.93
21 to 50	3000 to 5500	0.82	0.89	0.96	0.79	0.87	0.95	0.76	0.86	0.95
51 to 80	3500 to 6500	0.83	0.90	0.95	0.81	0.89	0.95	0.78	0.86	0.93
81 to 120	5000 to 7000	0.88	0.92	0.97	0.85	0.90	0.95	0.83	0.89	0.95
121 to 180	5500 to 7500	0.91	0.97	0.99	0.88	0.95	0.98	0.85	0.94	0.97

FIGURE 2–15 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 23, 26 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.01
11 to 20	0 to 70	1.02
21 to 30	0 to 40	1.03
31 to 40	0 to 10	1.04
41 to 50	0 to 10	1.05

C* x T x E = Hourly Capacity

EXIT FACTOR E

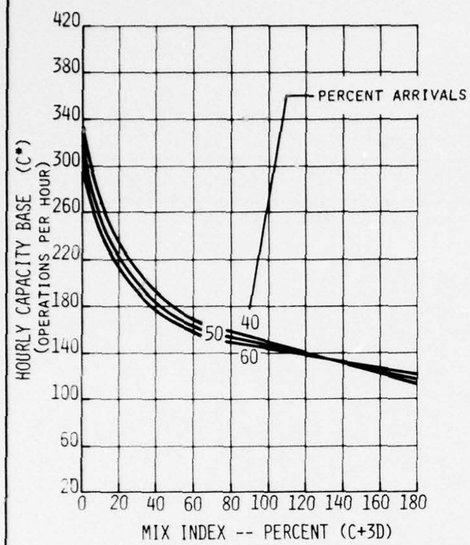
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.75	0.88	0.94	0.72	0.86	0.93	0.69	0.84	0.93
21 to 50	3000 to 5500	0.82	0.89	0.96	0.79	0.87	0.95	0.76	0.86	0.95
51 to 80	3500 to 6500	0.83	0.90	0.95	0.81	0.89	0.95	0.78	0.86	0.93
81 to 120	5000 to 7000	0.88	0.92	0.97	0.85	0.90	0.95	0.83	0.89	0.95
121 to 180	5500 to 7500	0.91	0.97	0.99	0.88	0.95	0.98	0.85	0.94	0.97

FIGURE 2–16 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 24, 25 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.01
11 to 20	0 to 70	1.02
21 to 30	0 to 40	1.03
31 to 40	0 to 10	1.04
41 to 50	0 to 10	1.05

C* x T x E = Hourly Capacity

EXIT FACTOR E

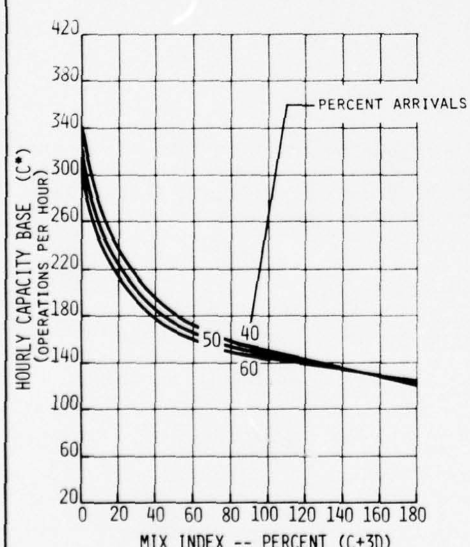
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.75	0.88	0.94	0.72	0.86	0.93	0.69	0.84	0.93
21 to 50	3000 to 5500	0.82	0.89	0.96	0.79	0.87	0.95	0.76	0.86	0.95
51 to 80	3500 to 6500	0.83	0.90	0.95	0.81	0.89	0.95	0.78	0.86	0.93
81 to 120	5000 to 7000	0.88	0.92	0.97	0.85	0.90	0.95	0.83	0.89	0.95
121 to 180	5500 to 7500	0.91	0.97	0.99	0.88	0.95	0.98	0.85	0.94	0.97

FIGURE 2–17 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 27, 28, 91, 116 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.04
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.20
31 to 40	0 to 10	1.31
41 to 50	0 to 10	1.40

C* x T x E = Hourly Capacity

EXIT FACTOR E

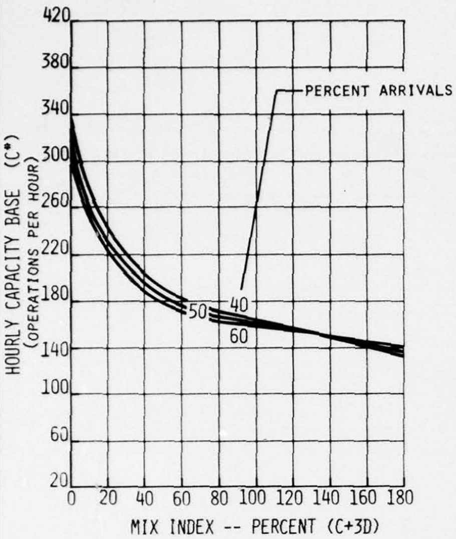
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.72	0.87	0.94	0.70	0.86	0.94	0.67	0.84	0.92
21 to 50	3000 to 5500	0.79	0.86	0.94	0.76	0.84	0.93	0.72	0.81	0.90
51 to 80	3500 to 6500	0.79	0.86	0.92	0.76	0.83	0.91	0.73	0.81	0.90
81 to 120	5000 to 7000	0.82	0.89	0.93	0.80	0.88	0.94	0.77	0.86	0.93
121 to 180	5500 to 7500	0.86	0.94	0.98	0.82	0.91	0.96	0.79	0.91	0.97

FIGURE 2–18 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 29 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.04
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.20
31 to 40	0 to 10	1.31
41 to 50	0 to 10	1.40

C* x T x E = Hourly Capacity

EXIT FACTOR E

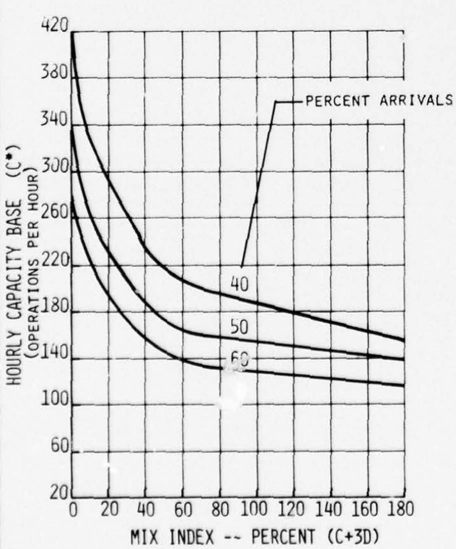
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.72	0.87	0.94	0.70	0.86	0.94	0.67	0.64	0.92
21 to 50	3000 to 5500	0.79	0.86	0.94	0.76	0.84	0.93	0.72	0.81	0.90
51 to 80	3500 to 6500	0.79	0.86	0.92	0.76	0.83	0.91	0.73	0.81	0.90
81 to 120	5000 to 7000	0.82	0.89	0.93	0.80	0.88	0.94	0.77	0.86	0.93
121 to 180	5500 to 7500	0.86	0.94	0.98	0.82	0.91	0.96	0.79	0.91	0.97

FIGURE 2–19 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 30, 31 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

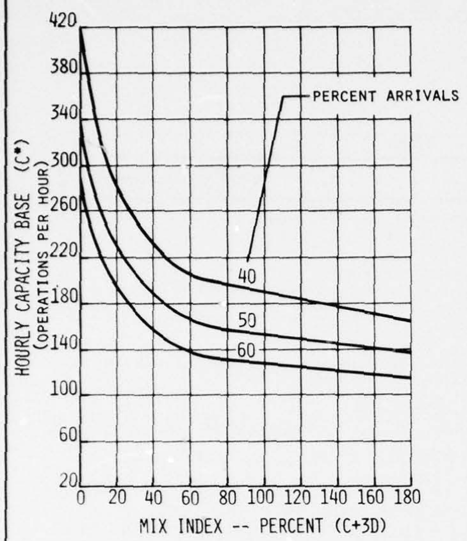
Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.62	0.79	0.90	0.62	0.79	0.90	0.62	0.79	0.90
21 to 50	3000 to 5500	0.72	0.83	0.93	0.72	0.83	0.93	0.72	0.83	0.93
51 to 80	3500 to 6500	0.75	0.84	0.92	0.75	0.84	0.92	0.75	0.84	0.92
81 to 120	5000 to 7000	0.80	0.87	0.94	0.80	0.87	0.94	0.80	0.87	0.94
121 to 180	5500 to 7500	0.94	1.00	1.00	0.83	0.93	0.97	0.83	0.93	0.97

FIGURE 2–20 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 32, 33 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*

TOUCH & GO FACTOR T

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.02
11 to 20	0 to 70	1.05
21 to 30	0 to 40	1.09

C* x T x E = Hourly Capacity

EXIT FACTOR E

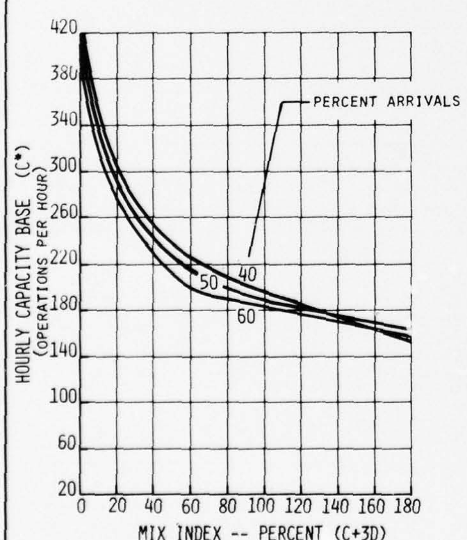
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.62	0.79	0.90	0.62	0.79	0.90	0.62	0.79	0.90
21 to 50	3000 to 5500	0.72	0.83	0.93	0.72	0.83	0.93	0.72	0.83	0.93
51 to 80	3500 to 6500	0.75	0.84	0.92	0.75	0.84	0.92	0.75	0.84	0.92
81 to 120	5000 to 7000	0.80	0.87	0.94	0.80	0.87	0.94	0.80	0.87	0.94
121 to 180	5500 to 7500	0.85	0.96	0.98	0.83	0.93	0.97	0.83	0.93	0.97

FIGURE 2–21 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 34, 35 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.09
21 to 30	0 to 40	1.14

C* x T x E = Hourly Capacity

EXIT FACTOR E

To determine Exit Factor E:

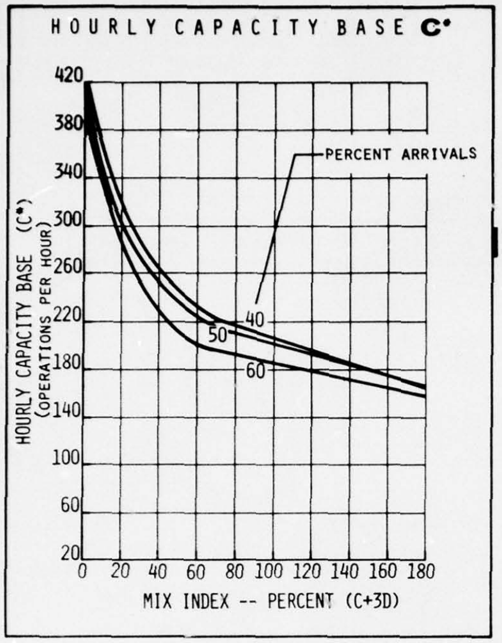
1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.76	0.88	0.94	0.72	0.86	0.94	0.64	0.82	0.93
21 to 50	3000 to 5500	0.83	0.90	0.96	0.80	0.88	0.95	0.72	0.83	0.93
51 to 80	3500 to 6500	0.85	0.91	0.95	0.82	0.89	0.95	0.75	0.84	0.92
81 to 120	5000 to 7000	0.89	0.93	0.97	0.87	0.91	0.95	0.81	0.87	0.94
121 to 180	5500 to 7500	0.94	0.98	0.99	0.92	0.97	0.99	0.89	0.96	0.98

FIGURE 2–22 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 36, 37, 38 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*

TOUCH & GO FACTOR T



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index-- Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.18

C* x T x E = Hourly Capacity

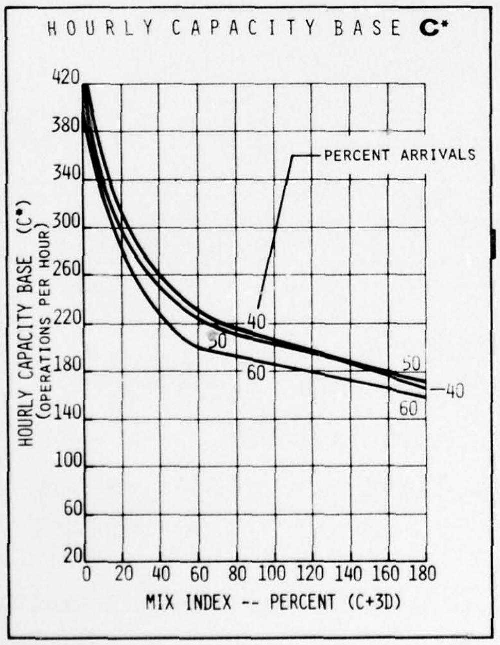
EXIT FACTOR E

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.76	0.88	0.94	0.72	0.86	0.94	0.64	0.82	0.93
21 to 50	3000 to 5500	0.83	0.90	0.96	0.80	0.88	0.95	0.72	0.83	0.93
51 to 80	3500 to 6500	0.85	0.91	0.95	0.82	0.89	0.95	0.75	0.84	0.92
81 to 120	5000 to 7000	0.89	0.93	0.97	0.87	0.91	0.96	0.81	0.87	0.94
121 to 180	5500 to 7500	0.94	0.98	0.99	0.92	0.97	0.99	0.89	0.96	0.98

FIGURE 2–23 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 39 FOR VFR CONDITIONS



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index-- Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.18

C* x T x E = Hourly Capacity

EXIT FACTOR E

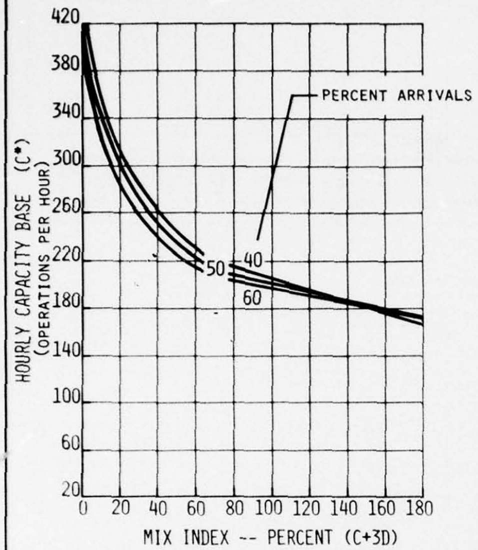
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.76	0.88	0.94	0.72	0.86	0.94	0.64	0.82	0.93
21 to 50	3000 to 5500	0.83	0.90	0.96	0.80	0.88	0.95	0.72	0.83	0.93
51 to 80	3500 to 6500	0.85	0.91	0.95	0.82	0.89	0.95	0.75	0.84	0.92
81 to 120	5000 to 7000	0.89	0.93	0.97	0.87	0.91	0.96	0.81	0.87	0.94
121 to 180	5500 to 7500	0.94	0.98	0.99	0.92	0.97	0.99	0.89	0.96	0.98

FIGURE 2–24 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 40 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.18

C* x T x E = Hourly Capacity

EXIT FACTOR E

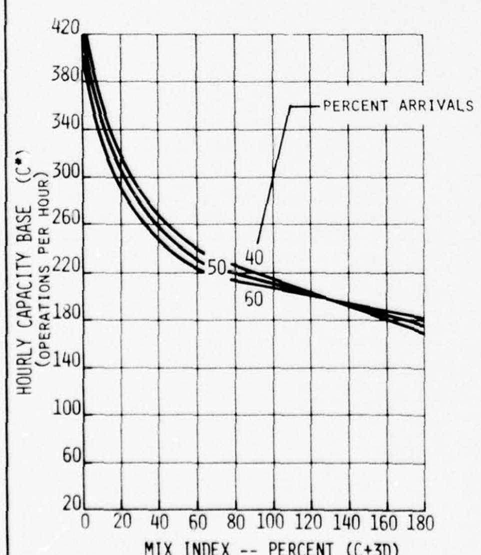
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.75	0.88	0.94	0.72	0.86	0.93	0.69	0.84	0.92
21 to 50	3000 to 5500	0.82	0.89	0.96	0.79	0.87	0.95	0.77	0.86	0.95
51 to 80	3500 to 6500	0.84	0.90	0.95	0.81	0.88	0.94	0.79	0.87	0.94
81 to 120	5000 to 7000	0.88	0.92	0.96	0.86	0.90	0.95	0.85	0.90	0.96
121 to 180	5500 to 7500	0.92	0.96	0.97	0.89	0.94	0.96	0.90	0.96	0.98

FIGURE 2–25 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 41 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.04
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.20
31 to 40	0 to 10	1.31
41 to 50	0 to 10	1.40

C* x T x E = Hourly Capacity

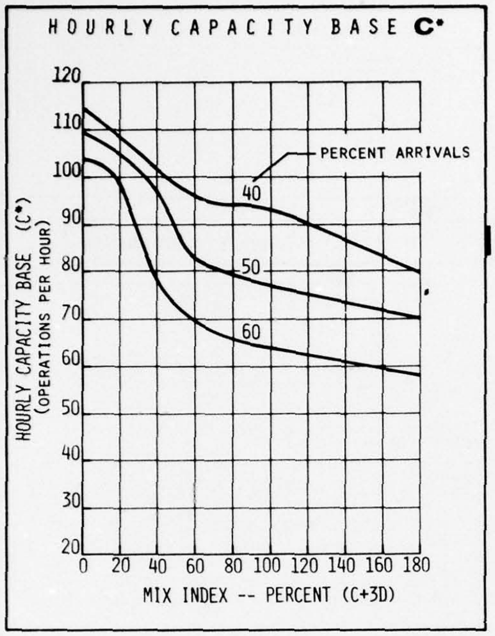
EXIT FACTOR E

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.72	0.87	0.94	0.70	0.86	0.94	0.67	0.84	0.92
21 to 50	3000 to 5500	0.79	0.86	0.94	0.76	0.84	0.93	0.72	0.81	0.90
51 to 80	3500 to 6500	0.79	0.86	0.92	0.76	0.83	0.91	0.73	0.81	0.90
81 to 120	5000 to 7000	0.83	0.89	0.93	0.80	0.87	0.94	0.77	0.86	0.93
121 to 180	5500 to 7500	0.85	0.93	0.98	0.81	0.91	0.97	0.78	0.89	0.97

FIGURE 2–26 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 42 FOR VFR CONDITIONS



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.06
21 to 30	0 to 40	1.13
31 to 40	0 to 10	1.26
41 to 50	0 to 10	1.33

C* x T x E = Hourly Capacity

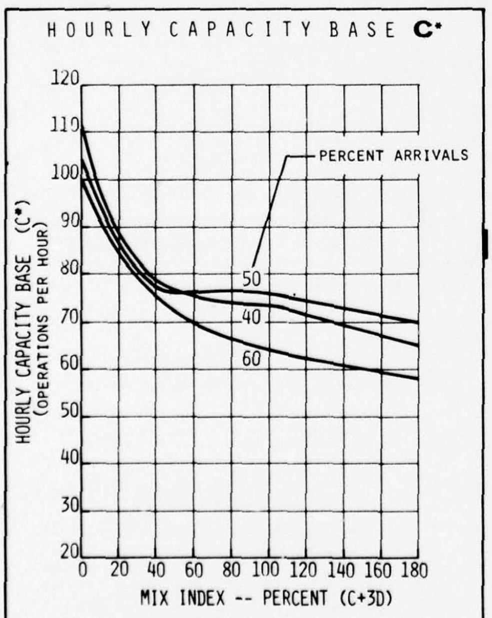
EXIT FACTOR E

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.86	0.88	0.94	0.80	0.85	0.93	0.71	0.83	0.93
21 to 50	3000 to 5500	0.84	0.91	0.98	0.71	0.85	0.92	0.71	0.85	0.92
51 to 80	3500 to 6500	0.81	0.91	0.97	0.76	0.85	0.91	0.75	0.84	0.91
81 to 120	5000 to 7000	0.83	0.90	0.95	0.80	0.86	0.92	0.80	0.87	0.92
121 to 180	5500 to 7500	0.93	0.99	1.00	0.84	0.94	0.98	0.85	0.94	0.98

FIGURE 2-27 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 43, 49 FOR VFR CONDITIONS



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.17
31 to 40	0 to 10	1.28
41 to 50	0 to 10	1.36

C* x T x E = Hourly Capacity

EXIT FACTOR E

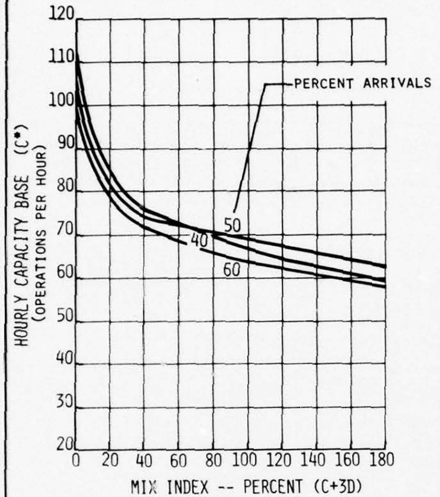
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.81	0.88	0.95	0.78	0.86	0.94	0.74	0.85	0.93
21 to 50	3000 to 5500	0.91	0.92	0.97	0.87	0.92	0.99	0.75	0.87	0.98
51 to 80	3500 to 6500	0.94	0.96	1.00	0.77	0.89	0.97	0.72	0.82	0.91
81 to 120	5000 to 7000	0.96	0.97	1.00	0.81	0.88	0.93	0.80	0.87	0.92
121 to 180	5500 to 7500	0.99	1.00	1.00	0.84	0.94	0.97	0.85	0.94	0.97

FIGURE 2-28 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 44, 50 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.17
31 to 40	0 to 10	1.28
41 to 50	0 to 10	1.36

C* x T x E = Hourly Capacity

EXIT FACTOR E

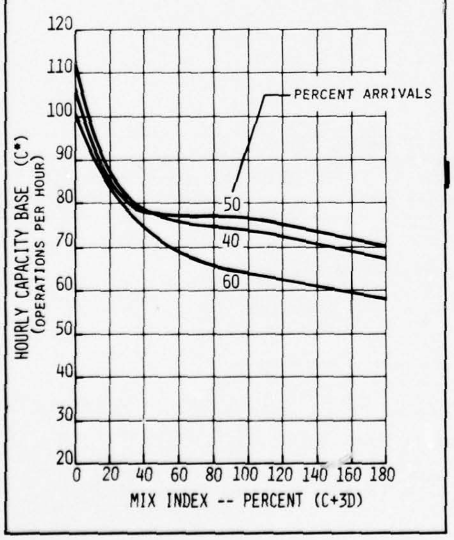
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.81	0.88	0.94	0.78	0.86	0.93	0.74	0.84	0.92
21 to 50	3000 to 5500	0.94	0.97	0.99	0.91	0.97	0.99	0.80	0.94	[illegible]
51 to 80	3500 to 6500	0.95	0.97	1.00	0.83	0.93	1.00	0.74	0.82	[illegible]
81 to 120	5000 to 7000	0.98	0.99	1.00	0.89	0.97	1.00	0.80	0.87	0.92
121 to 180	5500 to 7500	1.00	1.00	1.00	0.95	1.00	1.00	0.86	[illegible]	0.97

FIGURE 2-29 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 45, 51 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.19
31 to 40	0 to 10	1.31
41 to 50	0 to 10	1.40

C* x T x E = Hourly Capacity

EXIT FACTOR E

To determine Exit Factor E:

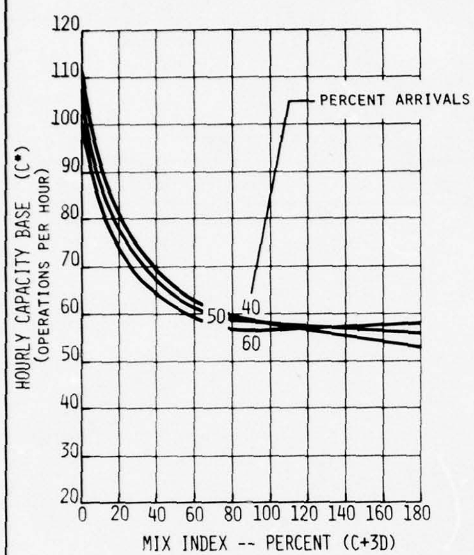
1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.74	0.86	0.92	0.70	0.84	0.92	0.67	0.82	0.91
21 to 50	3000 to 5500	0.86	0.88	0.92	0.83	0.86	0.91	0.74	0.84	0.90
51 to 80	3500 to 6500	0.90	0.91	0.96	0.79	0.88	0.97	0.72	0.84	0.91
81 to 120	5000 to 7000	0.94	0.95	0.98	0.80	0.86	0.92	0.80	0.87	0.92
121 to 180	5500 to 7500	0.98	0.99	1.00	0.84	0.94	0.97	0.85	0.94	0.97

FIGURE 2-30 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 46, 52 FOR VFR CONDITIONS

FIGURE 2–4 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 2, 67, 72, 73, 97, 98 FOR VFR CONDITIONS

HOURLY CAPACITY BASE **C***



TOUCH & GO FACTOR **T**

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.19
31 to 40	0 to 10	1.31
41 to 50	0 to 10	1.40

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

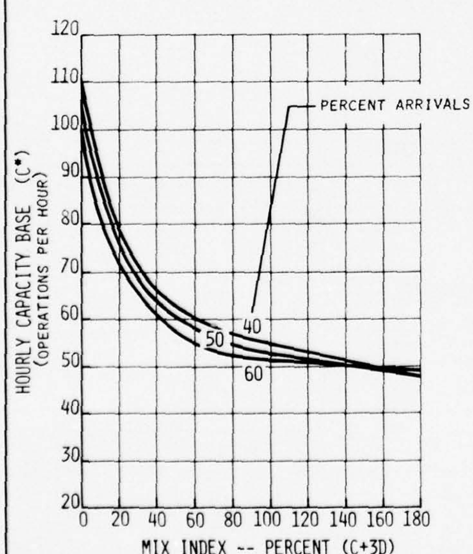
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.73	0.88	0.95	0.71	0.87	0.94	0.68	0.85	0.93
21 to 50	3000 to 5500	0.89	0.92	0.95	0.87	0.90	0.94	0.84	0.89	0.94
51 to 80	3500 to 6500	0.96	0.97	0.99	0.95	0.96	0.98	0.89	0.94	0.97
81 to 120	5000 to 7000	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.97	1.00
121 to 180	5500 to 7500	1.00	1.00	1.00	1.00	1.00	1.00	0.84	0.94	0.98

FIGURE 2–31 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 47, 53 FOR VFR CONDITIONS

HOURLY CAPACITY BASE **C***



TOUCH & GO FACTOR **T**

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

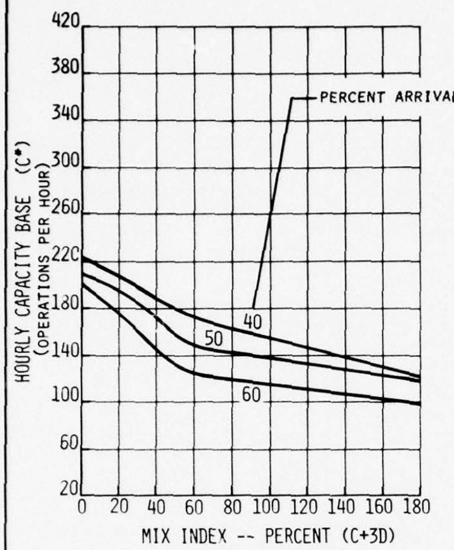
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.74	0.88	0.95	0.72	0.87	0.94	0.69	0.85	0.93
21 to 50	3000 to 5500	0.90	0.93	0.97	0.88	0.91	0.95	0.86	0.90	0.95
51 to 80	3500 to 6500	0.97	0.98	1.00	0.95	0.96	0.98	0.92	0.97	0.99
81 to 120	5000 to 7000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
121 to 180	5500 to 7500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

FIGURE 2–32 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 48 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.04
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.20
31 to 40	0 to 10	1.28
41 to 50	0 to 10	1.36

C* x T x E = Hourly Capacity

EXIT FACTOR E

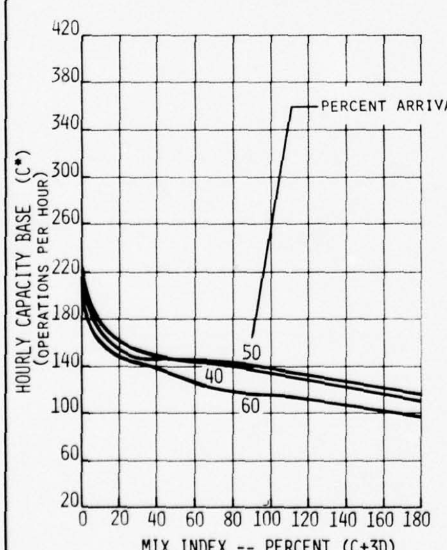
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Facto. from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.86	0.87	0.94	0.82	0.85	0.93	0.77	0.84	0.92
21 to 50	3000 to 5500	0.88	0.91	0.96	0.73	0.86	0.94	0.73	0.86	0.94
51 to 80	3500 to 6500	0.84	0.87	0.93	0.78	0.87	0.93	0.78	0.87	0.93
81 to 120	5000 to 7000	0.83	0.90	0.96	0.83	0.90	0.96	0.83	0.90	0.96
121 to 180	5500 to 7500	1.00	1.00	1.00	0.92	0.97	1.00	0.92	0.97	1.00

FIGURE 2-33 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 55, 61 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

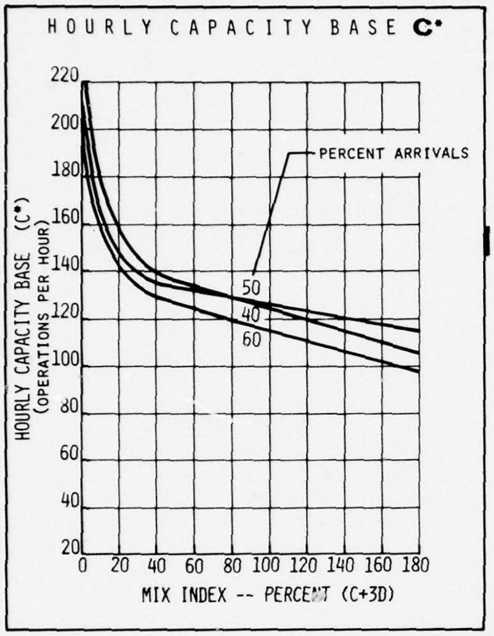
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.79	0.89	0.95	0.76	0.88	0.95	0.74	0.86	0.94
21 to 50	3000 to 5500	0.96	1.00	1.00	0.91	1.00	1.00	0.78	0.92	0.97
51 to 80	3500 to 6500	0.93	0.96	1.00	0.80	0.90	0.97	0.78	0.87	0.93
81 to 120	5000 to 7000	0.93	0.96	1.00	0.83	0.90	0.96	0.83	0.90	0.96
121 to 180	5500 to 7500	0.97	0.99	1.00	0.93	0.97	1.00	0.92	0.97	1.00

FIGURE 2-34 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 56 FOR VFR CONDITIONS

FIGURE 2–8 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. ... 79, 104 FOR VFR CONDITIONS



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.17
31 to 40	0 to 10	1.28
41 to 50	0 to 10	1.36

C* x T x E = Hourly Capacity

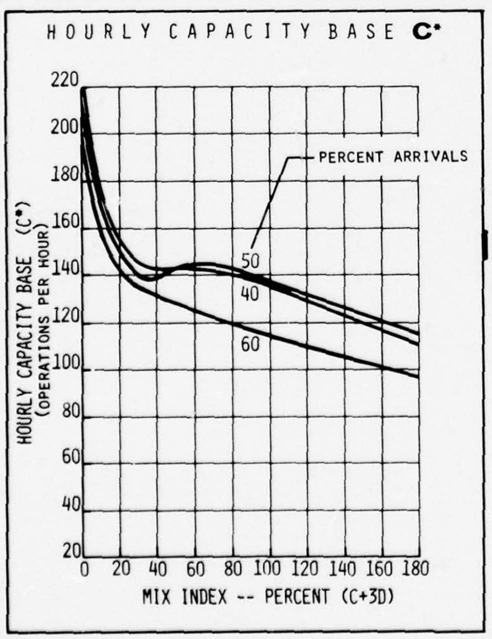
EXIT FACTOR E

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.83	0.89	0.95	0.81	0.88	0.95	0.79	0.86	0.94
21 to 50	3000 to 5500	1.00	1.00	1.00	0.98	1.00	1.00	0.85	1.00	1.00
51 to 80	3500 to 6500	0.95	0.98	1.00	0.87	0.97	1.00	0.78	0.87	0.93
81 to 120	5000 to 7000	0.95	0.98	1.00	0.90	0.97	1.00	0.83	0.90	0.96
121 to 180	5500 to 7500	0.97	1.00	1.00	0.95	1.00	1.00	0.92	0.97	1.00

FIGURE 2–35 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 57, 63 FOR VFR CONDITIONS



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.17
31 to 40	0 to 10	1.28
41 to 50	0 to 10	1.36

C* x T x E = Hourly Capacity

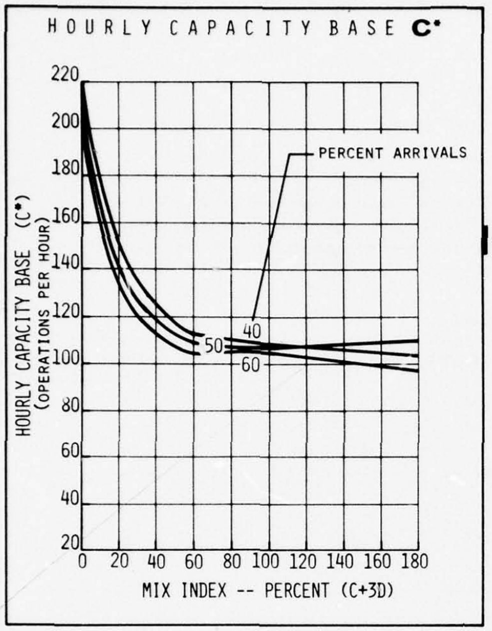
EXIT FACTOR E

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.78	0.89	0.95	0.75	0.88	0.95	0.72	0.86	0.94
21 to 50	3000 to 5500	0.96	0.96	0.98	0.95	0.95	0.98	0.83	0.94	0.98
51 to 80	3500 to 6500	0.90	0.93	0.97	0.81	0.90	0.96	0.78	0.87	0.94
81 to 120	5000 to 7000	0.92	0.95	0.98	0.83	0.90	0.96	0.83	0.90	0.96
121 to 180	5500 to 7500	0.98	1.00	1.00	0.92	0.97	1.00	0.92	0.97	1.00

FIGURE 2-36 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 58, 64 FOR VFR CONDITIONS



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index-- Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.04
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.20
31 to 40	0 to 10	1.28
41 to 50	0 to 10	1.36

C* x T x E = Hourly Capacity

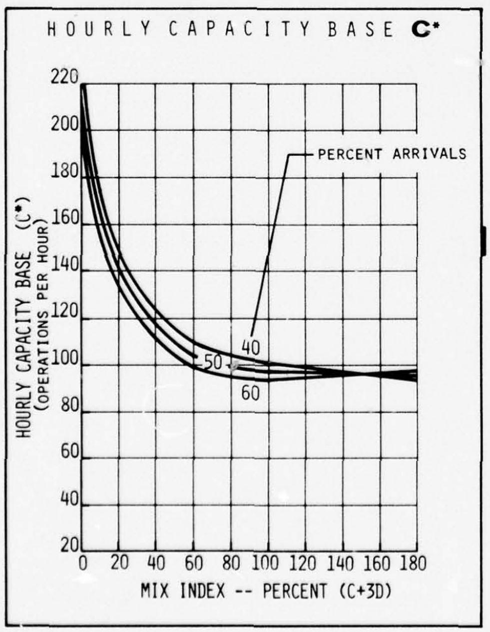
EXIT FACTOR E

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.78	0.89	0.95	0.75	0.88	0.95	0.72	0.86	0.94
21 to 50	3000 to 5500	0.89	0.92	0.97	0.87	0.91	0.96	0.86	0.90	0.95
51 to 80	3500 to 6500	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.99	1.00
81 to 120	5000 to 7000	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.97	1.00
121 to 180	5500 to 7500	0.98	1.00	1.00	0.98	1.00	1.00	0.92	0.97	1.00

FIGURE 2–37 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 59, 65 FOR VFR CONDITIONS



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

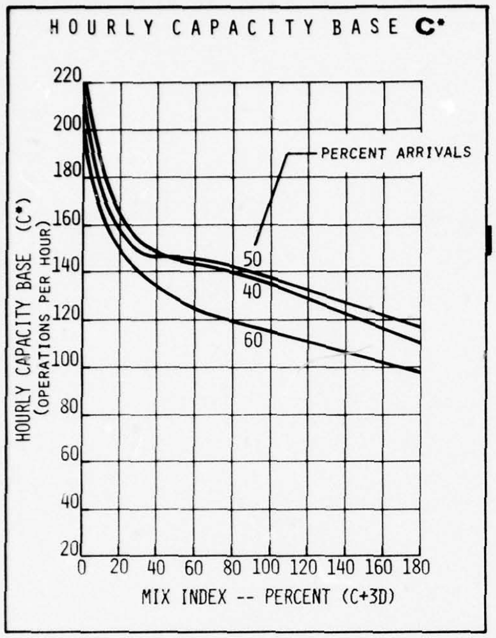
EXIT FACTOR E

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.78	0.89	0.95	0.75	0.88	0.95	0.72	0.86	0.94
21 to 50	3000 to 5500	0.87	0.92	0.97	0.85	0.91	0.96	0.83	0.90	0.95
51 to 80	3500 to 6500	0.98	0.99	1.00	0.99	0.99	1.00	0.97	0.98	1.00
81 to 120	5000 to 7000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
121 to 180	5500 to 7500	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.97	1.00

FIGURE 2–38 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 60 FOR VFR CONDITIONS



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.04
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.20
31 to 40	0 to 10	1.31
41 to 50	0 to 10	1.40

C* x T x E = Hourly Capacity

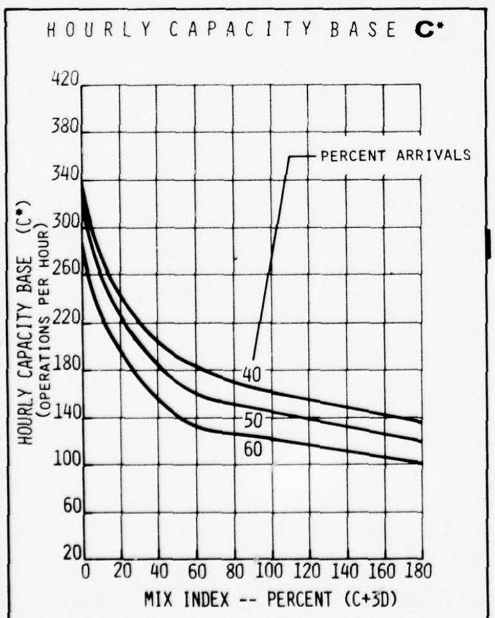
EXIT FACTOR E

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.70	0.86	0.93	0.67	0.85	0.92	0.64	0.83	0.91
21 to 50	3000 to 5500	0.96	1.00	1.00	0.91	1.00	1.00	0.78	0.92	0.97
51 to 80	3500 to 6500	0.93	0.96	1.00	0.80	0.90	0.97	0.78	0.87	0.93
81 to 120	5000 to 7000	0.93	0.96	1.00	0.83	0.90	0.96	0.83	0.90	0.96
121 to 180	5500 to 7500	0.97	0.99	1.00	0.93	0.97	1.00	0.92	0.97	1.00

FIGURE 2–39 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 62 FOR VFR CONDITIONS



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.10
21 to 30	0 to 40	1.18

C* x T x E = Hourly Capacity

EXIT FACTOR E

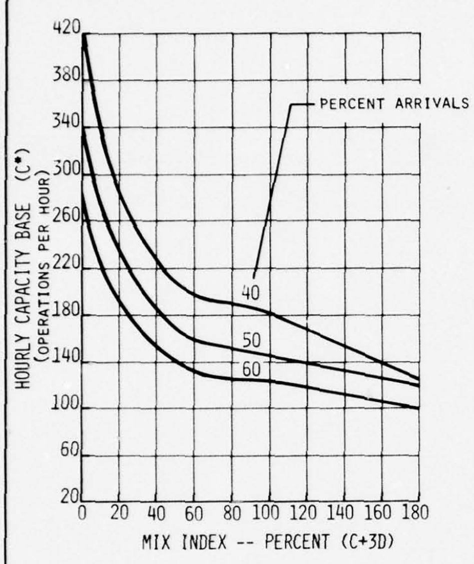
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.75	0.87	0.94	0.64	0.82	0.93	0.62	0.79	0.90
21 to 50	3000 to 5500	0.81	0.89	0.96	0.72	0.83	0.93	0.72	0.83	0.93
51 to 80	3500 to 6500	0.81	0.90	0.95	0.75	0.84	0.92	0.75	0.84	0.92
81 to 120	5000 to 7000	0.88	0.92	0.97	0.81	0.87	0.94	0.81	0.87	0.94
121 to 180	5500 to 7500	0.93	0.97	0.98	0.89	0.96	0.98	0.89	0.96	0.98

FIGURE 2–40 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 86, 87, 88, 89, 90, 111, 112, 113, 114, 115 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.05
21 to 30	0 to 40	1.09
31 to 40	0 to 10	1.15
41 to 50	0 to 10	1.20

C* x T x E = Hourly Capacity

EXIT FACTOR E

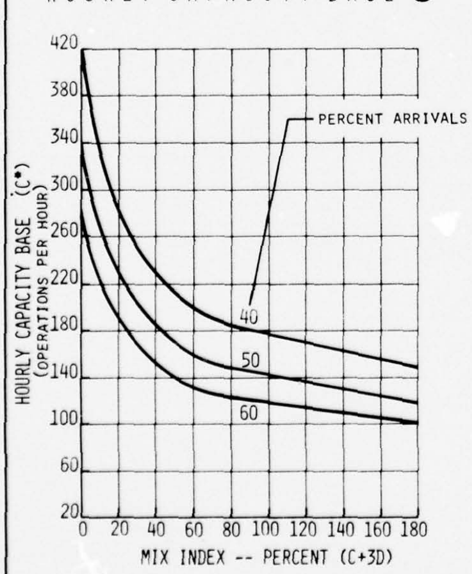
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.62	0.79	0.90	0.62	0.79	0.90	0.62	0.79	0.90
21 to 50	3000 to 5500	0.72	0.83	0.93	0.72	0.83	0.93	0.72	0.83	0.93
51 to 80	3500 to 6500	0.75	0.84	0.92	0.75	0.84	0.92	0.75	0.84	0.92
81 to 120	5000 to 7000	0.81	0.87	0.94	0.81	0.87	0.94	0.81	0.87	0.94
121 to 180	5500 to 7500	1.00	1.00	1.00	0.89	0.96	0.98	0.89	0.96	0.98

FIGURE 2-41 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 92, 93, 117, 118, 122 FOR VFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

Percent Touch & Go	Mix Index--Percent (C+3D)	TOUCH & GO FACTOR T
0	0 to 180	1.00
1 to 10	0 to 70	1.03
11 to 20	0 to 70	1.05
21 to 30	0 to 40	1.09
31 to 40	0 to 10	1.15
41 to 50	0 to 10	1.20

C* x T x E = Hourly Capacity

EXIT FACTOR E

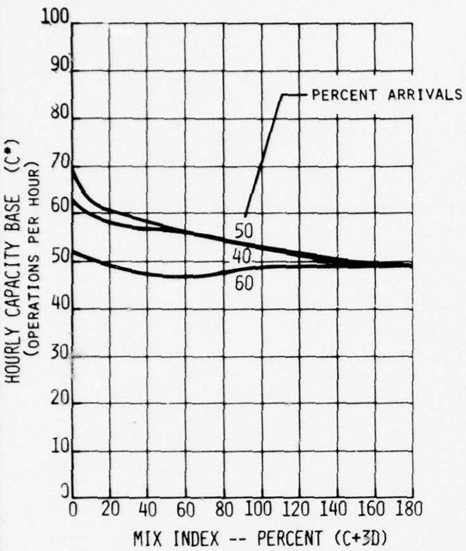
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.62	0.79	0.90	0.62	0.79	0.90	0.62	0.79	0.90
21 to 50	3000 to 5500	0.72	0.83	0.93	0.72	0.83	0.93	0.72	0.83	0.93
51 to 80	3500 to 6500	0.75	0.84	0.92	0.75	0.84	0.92	0.75	0.84	0.92
81 to 120	5000 to 7000	0.81	0.87	0.94	0.81	0.87	0.94	0.81	0.87	0.94
121 to 180	5500 to 7500	0.89	0.96	0.98	0.89	0.96	0.98	0.89	0.96	0.98

FIGURE 2-42 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 94, 95, 96, 119, 120, 121 FOR VFR CONDITIONS

HOURLY CAPACITY BASE **C***



TOUCH & GO FACTOR **T**

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

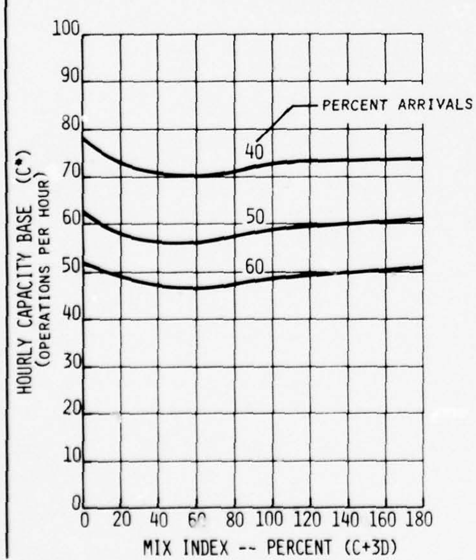
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D) 2-43, 2-50	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.81	0.91	0.96	0.83	0.95	0.99	0.92	1.00	1.00
21 to 50	3000 to 5500	0.79	0.86	0.92	0.77	0.85	0.92	0.89	0.98	1.00
51 to 80	3500 to 6500	0.81	0.87	0.93	0.77	0.83	0.91	0.90	0.98	1.00
81 to 120	5000 to 7000	0.83	0.89	0.94	0.80	0.86	0.92	0.83	0.91	0.97
121 to 180	5500 to 7500	0.86	0.94	0.98	0.83	0.91	0.96	0.79	0.89	0.95

FIGURE 2–43 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 1, 54 FOR IFR CONDITIONS

HOURLY CAPACITY BASE **C***



TOUCH & GO FACTOR **T**

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

To determine Exit Factor E:

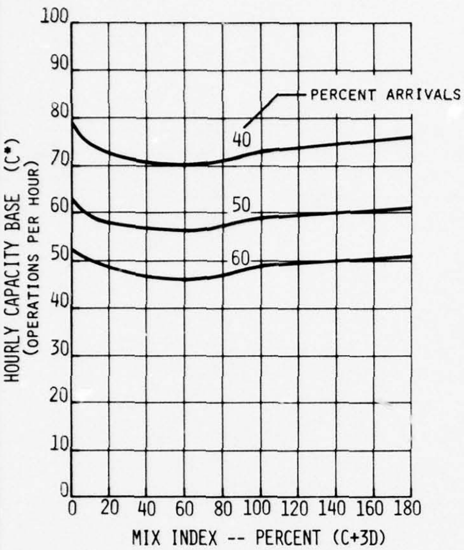
1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	0.90	0.96	0.98	0.90	0.96	0.98	0.90	0.96	0.98
51 to 80	3500 to 6500	0.91	0.97	1.00	0.91	0.97	1.00	0.91	0.97	1.00
81 to 120	5000 to 7000	0.91	0.98	1.00	0.91	0.98	1.00	0.91	0.98	1.00
121 to 180	5500 to 7500	0.92	0.97	1.00	0.90	0.97	1.00	0.90	0.97	1.00

FIGURE 2–44

HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 2, 3, 4, 6, 9, 61, 62, 63, 64, 65, 66, 67, 68, 72, 73, 74, 76, 79, 85, 91, 92, 93, 97, 98, 99, 101, 104, 110, 116, 117, 118, 122 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

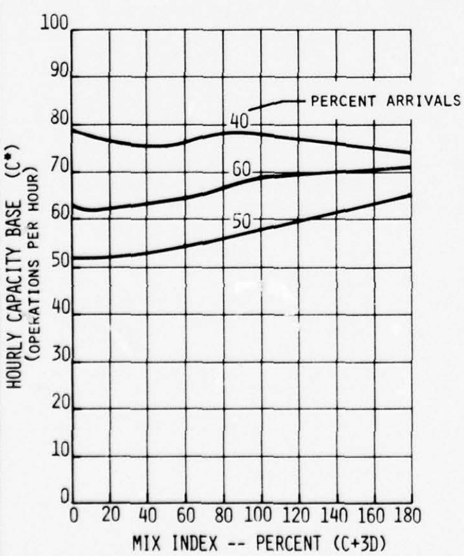
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	0.90	0.96	0.98	0.90	0.96	0.98	0.90	0.96	0.98
51 to 80	3500 to 6500	0.91	0.97	1.00	0.91	0.97	1.00	0.91	0.97	1.00
81 to 120	5000 to 7000	0.91	0.98	1.00	0.91	0.98	1.00	0.91	0.98	1.00
121 to 180	5500 to 7500	0.92	0.97	1.00	0.90	0.97	1.00	0.90	0.97	1.00

FIGURE 2–45 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 5, 75, 77, 78, 100, 102, 103 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

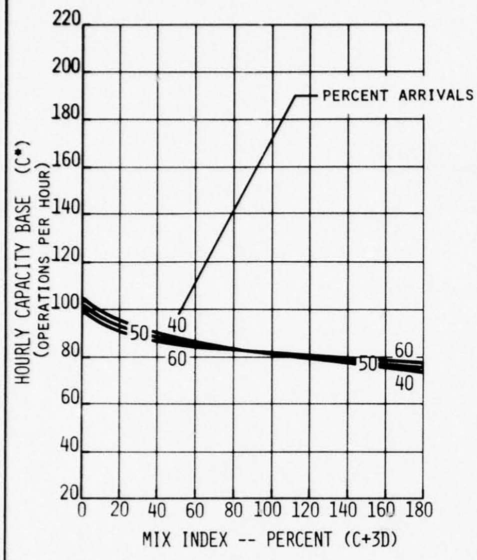
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
21 to 50	3000 to 5500	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
51 to 80	3500 to 6500	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
81 to 120	5000 to 7000	0.98	0.99	1.00	0.98	0.99	1.00	1.00	1.00	1.00
121 to 180	5500 to 7500	1.00	1.00	1.00	0.97	0.99	1.00	0.97	1.00	1.00

FIGURE 2–46 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 7 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR **T**

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

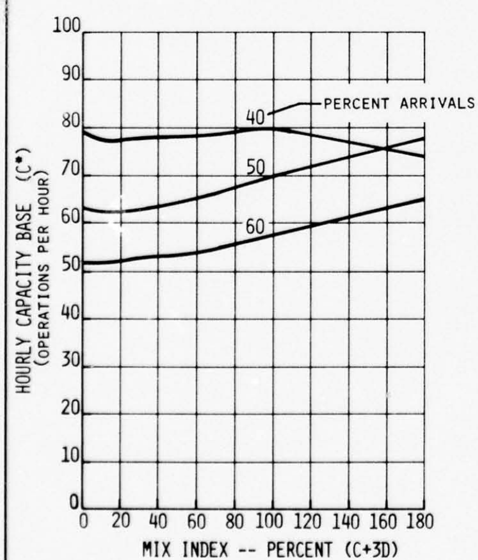
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.99	1.00	1.00	0.99	1.00	1.00	0.98	0.99	1.00
21 to 50	3000 to 5500	0.95	0.98	0.99	0.93	0.98	0.99	0.91	0.97	0.99
51 to 80	3500 to 6500	0.95	0.98	1.00	0.94	0.99	1.00	0.92	0.98	1.00
81 to 120	5000 to 7000	0.96	0.99	1.00	0.94	0.99	1.00	0.93	0.99	1.00
121 to 180	5500 to 7500	0.98	1.00	1.00	0.95	1.00	1.00	0.94	0.99	1.00

FIGURE 2–47 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 8 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR **T**

T = 1.00

C* x T x E = Hourly Capacity

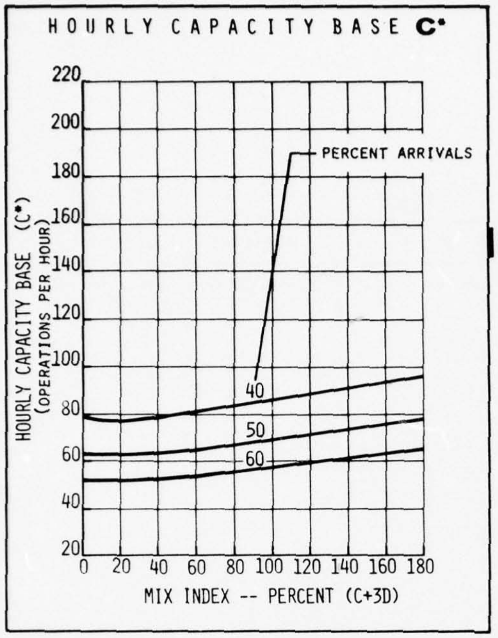
EXIT FACTOR **E**

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits (N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E
0 to 20	2000 to 4000	E = 1.00
21 to 50	3000 to 5500	
51 to 80	3500 to 6500	
81 to 120	5000 to 7000	
121 to 180	5500 to 7500	

FIGURE 2–48 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 10, 29, 69 FOR IFR CONDITIONS



TOUCH & GO FACTOR **T**

T = 1.00

C* x T x E = Hourly Capacity

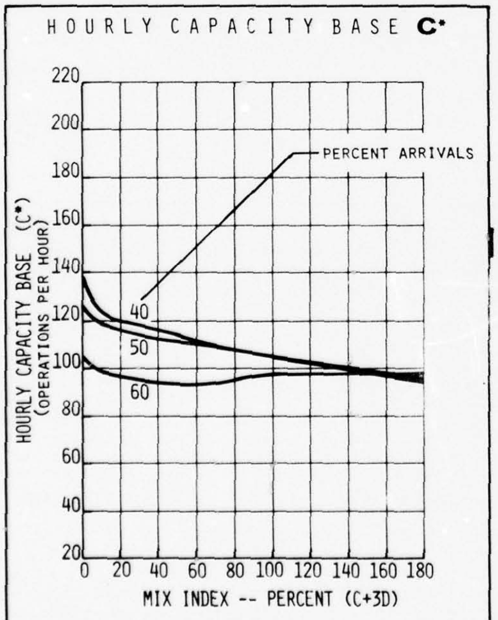
EXIT FACTOR **E**

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
21 to 50	3000 to 5500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
51 to 80	3500 to 6500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
81 to 120	5000 to 7000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
121 to 180	5500 to 7500	0.89	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00

FIGURE 2–49 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 11, 70 FOR IFR CONDITIONS



TOUCH & GO FACTOR **T**

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

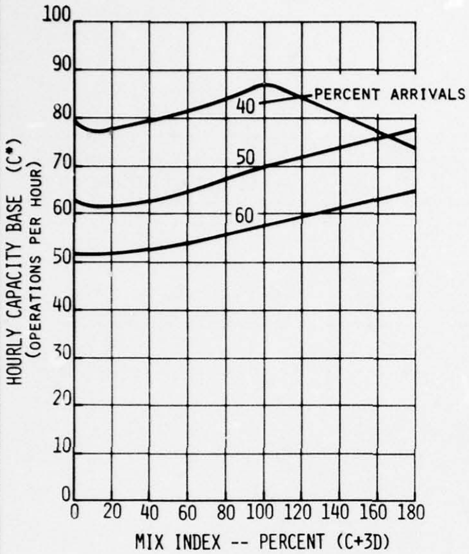
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D) 2-43, 2-50	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.81	0.91	0.96	0.83	0.95	0.99	0.92	1.00	1.00
21 to 50	3000 to 5500	0.79	0.86	0.92	0.77	0.85	0.92	0.89	0.98	1.00
51 to 80	3500 to 6500	0.81	0.87	0.93	0.77	0.83	0.91	0.90	0.98	1.00
81 to 120	5000 to 7000	0.83	0.89	0.94	0.80	0.86	0.92	0.83	0.91	0.97
121 to 180	5500 to 7500	0.86	0.94	0.98	0.83	0.91	0.96	0.79	0.89	0.95

FIGURE 2–50 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 12, 71 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

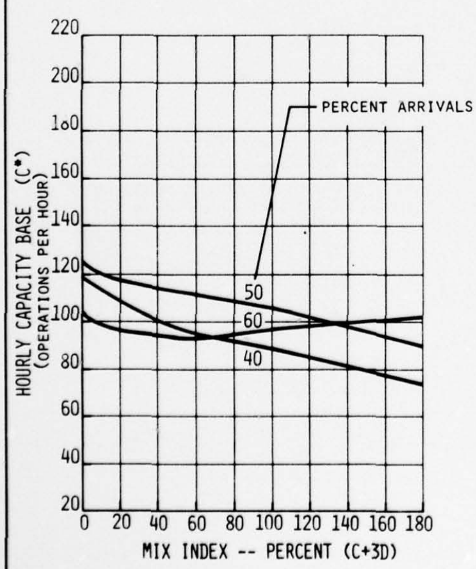
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E
0 to 20	2000 to 4000	E = 1.00
21 to 50	3000 to 5500	
51 to 80	3500 to 6500	
81 to 120	5000 to 7000	
121 to 180	5500 to 7500	

FIGURE 2–51 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 13, 15, 16, 23, 24, 26, 27 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

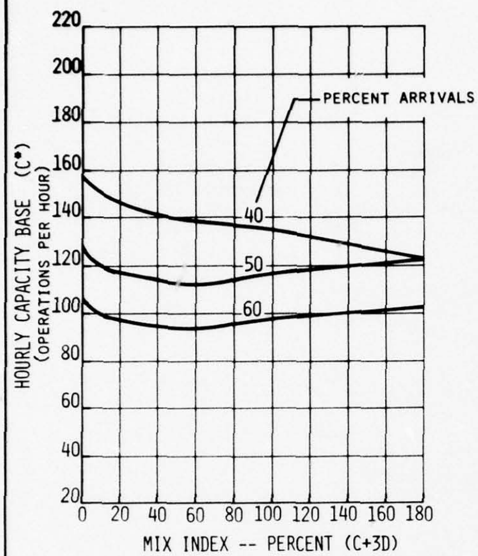
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E: 40% Arrivals N=0	40% Arrivals N=1	40% Arrivals N=2 or 3	50% Arrivals N=0	50% Arrivals N=1	50% Arrivals N=2 or 3	60% Arrivals N=0	60% Arrivals N=1	60% Arrivals N=2 or 3
0 to 20	2000 to 4000	1.00	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	1.00	1.00	1.00	0.90	0.96	0.98	0.90	0.96	0.98
51 to 80	3500 to 6500	1.00	1.00	1.00	0.91	0.97	1.00	0.91	0.97	1.00
81 to 120	5000 to 7000	1.00	1.00	1.00	1.00	1.00	1.00	0.91	0.98	1.00
121 to 180	5500 to 7500	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.97	1.00

FIGURE 2–52 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 14, 28 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

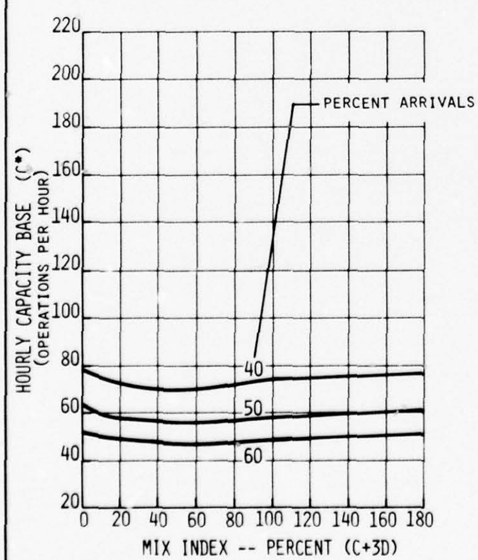
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.98	0.99	1.00	0.98	0.99	1.00	0.98	0.99	1.00
21 to 50	3000 to 5500	0.90	0.96	0.98	0.90	0.96	0.98	0.90	0.96	0.98
51 to 80	3500 to 6500	0.92	0.98	1.00	0.92	0.98	1.00	0.91	0.97	1.00
81 to 120	5000 to 7000	0.95	0.99	1.00	0.92	0.99	1.00	0.91	0.98	1.00
121 to 180	5500 to 7500	0.95	0.99	1.00	0.90	0.97	1.00	0.90	0.97	1.00

FIGURE 2-53 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 17, 20, 25, 31, 36 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

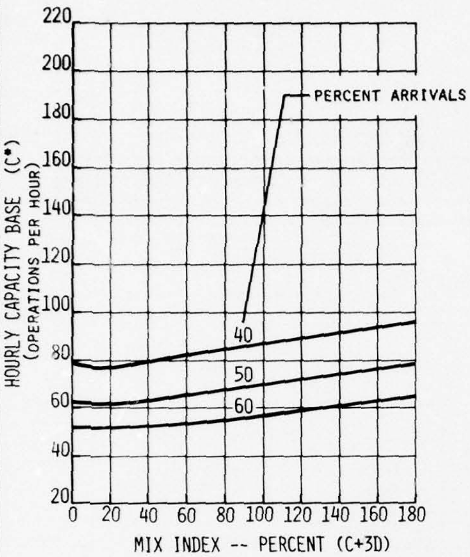
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	0.90	0.96	0.98	0.90	0.96	0.98	0.90	0.96	0.98
51 to 80	3500 to 6500	0.91	0.97	1.00	0.91	0.97	1.00	0.91	0.97	1.00
81 to 120	5000 to 7000	0.91	0.98	1.00	0.91	0.98	1.00	0.91	0.98	1.00
121 to 180	5500 to 7500	0.92	0.97	1.00	0.90	0.97	1.00	0.90	0.97	1.00

FIGURE 2-54 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 18, 21, 80, 82, 86, 88, 94, 105, 107, 111, 113, 119 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

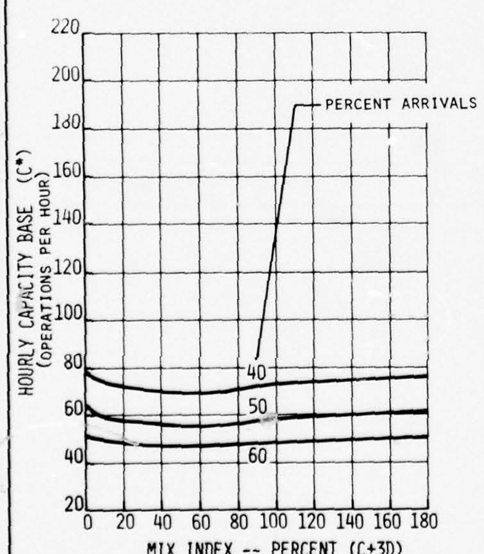
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E
0 to 20	2000 to 4000	E = 1.00
21 to 50	3000 to 5500	
51 to 80	3500 to 6500	
81 to 120	5000 to 7000	
121 to 180	5500 to 7500	

FIGURE 2-55 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 19, 30 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

To determine Exit Factor E:

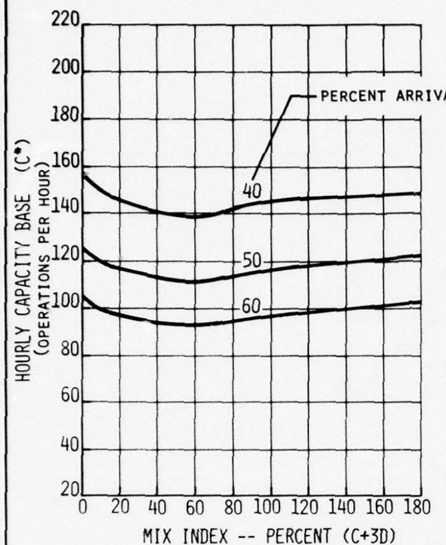
1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	0.90	0.96	0.98	0.90	0.96	0.98	0.90	0.96	0.98
51 to 80	3500 to 6500	0.91	0.97	1.00	0.91	0.97	1.00	0.91	0.97	1.00
81 to 120	5000 to 7000	0.91	0.98	1.00	0.91	0.98	1.00	0.91	0.98	1.00
121 to 180	5500 to 7500	0.92	0.97	1.00	0.90	0.97	1.00	0.90	0.97	1.00

FIGURE 2-56 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 22, 81, 83, 84, 87, 89, 90, 95, 96, 106, 108, 109, 112, 114, 115, 120, 121 FOR IFR CONDITIONS

FIGURE 2–30 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 46, 52 FOR VFR CONDITIONS

HOURLY CAPACITY BASE **C***



TOUCH & GO FACTOR **T**

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

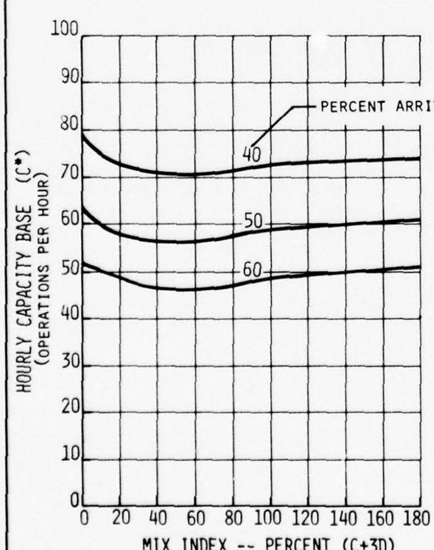
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	0.90	0.96	0.98	0.90	0.96	0.98	0.90	0.96	0.98
51 to 80	3500 to 6500	0.91	0.97	1.00	0.91	0.97	1.00	0.91	0.97	1.00
81 to 120	5000 to 7000	0.91	0.98	1.00	0.91	0.98	1.00	0.91	0.98	1.00
121 to 180	5500 to 7500	0.92	0.97	1.00	0.90	0.97	1.00	0.90	0.97	1.00

FIGURE 2–57 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS, 32, 33, 34, 35, 37, 38, 39, 40, 41, 42 FOR IFR CONDITIONS

HOURLY CAPACITY BASE **C***



TOUCH & GO FACTOR **T**

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR **E**

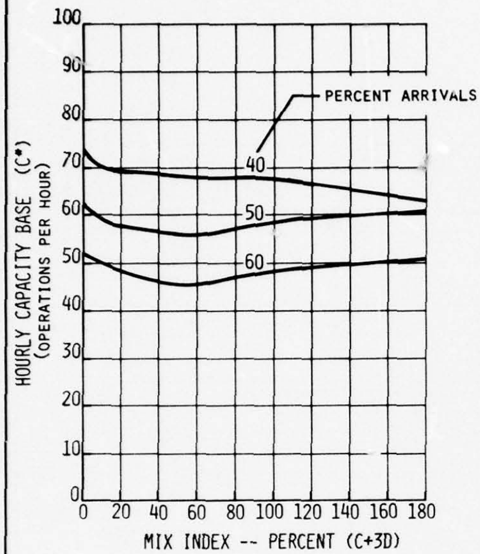
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.98	1.00	1.00	0.99	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	0.92	0.99	1.00	0.91	0.99	1.00	0.92	1.00	1.00
51 to 80	3500 to 6500	0.91	0.98	1.00	0.90	0.97	1.00	0.92	0.99	1.00
81 to 120	5000 to 7000	0.94	0.98	1.00	0.91	0.97	1.00	0.91	0.97	1.00
121 to 180	5500 to 7500	0.95	1.00	1.00	0.92	0.99	1.00	0.91	0.99	1.00

FIGURE 2–58 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 43, 49, 55 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

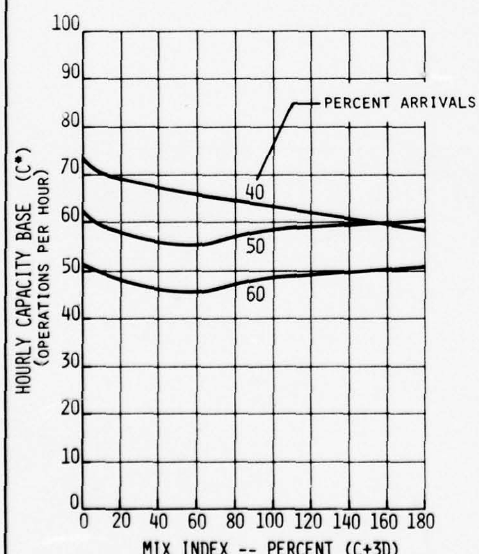
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.98	1.00	1.00	0.99	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	0.92	0.99	1.00	0.91	0.99	1.00	0.92	1.00	1.00
51 to 80	3500 to 6500	0.91	0.98	1.00	0.90	0.97	1.00	0.92	0.99	1.00
81 to 120	5000 to 7000	0.94	0.98	1.00	0.91	0.97	1.00	0.91	0.97	1.00
121 to 180	5500 to 7500	0.95	1.00	1.00	0.92	0.99	1.00	0.91	0.99	1.00

FIGURE 2–59 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 44, 50, 56 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

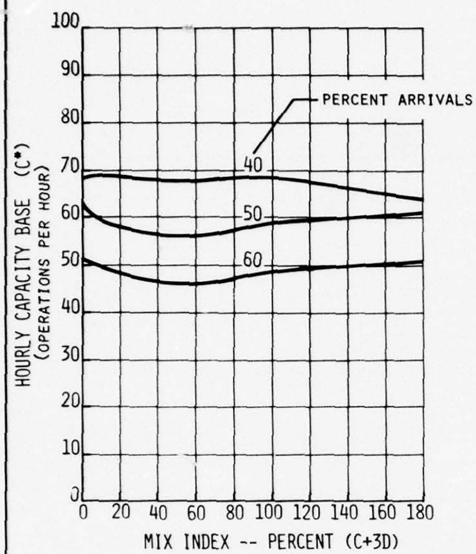
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index--Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.99	1.00	1.00	0.99	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	0.96	1.00	1.00	0.92	0.99	1.00	0.93	1.00	1.00
51 to 80	3500 to 6500	0.93	1.00	1.00	0.90	0.97	1.00	0.90	0.98	1.00
81 to 120	5000 to 7000	0.99	1.00	1.00	0.91	0.97	1.00	0.91	0.97	1.00
121 t0 180	5500 to 7500	1.00	1.00	1.00	0.92	0.99	1.00	0.92	0.99	1.00

FIGURE 2–60 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 45, 51, 57 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

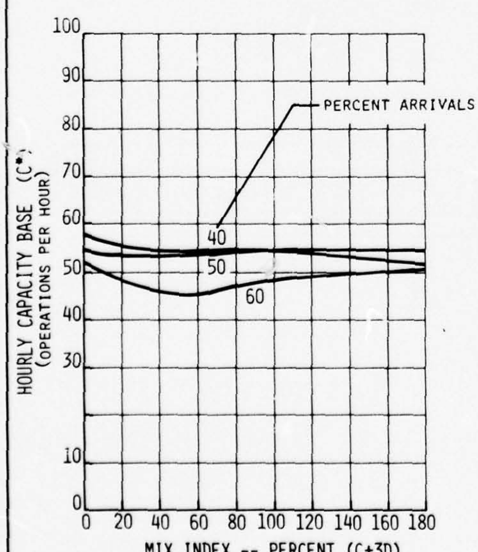
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.94	0.95	1.00	0.99	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	0.95	0.98	1.00	0.93	0.99	1.00	0.93	1.00	1.00
51 to 80	3500 to 6500	0.92	0.97	1.00	0.90	0.97	1.00	0.90	0.98	1.00
81 to 120	5000 to 7000	0.96	0.98	1.00	0.91	0.97	1.00	0.91	0.97	1.00
121 to 180	5500 to 7500	0.98	1.00	1.00	0.92	0.99	1.00	0.92	0.99	1.00

FIGURE 2–61 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 46, 52, 58 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

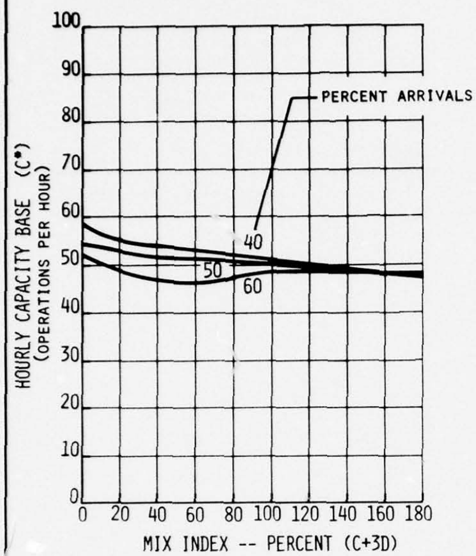
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	1.00	1.00	1.00	0.97	1.00	1.00	0.91	1.00	1.00
51 to 80	3500 to 6500	1.00	1.00	1.00	0.94	1.00	1.00	0.92	0.99	1.00
81 to 120	5000 to 7000	1.00	1.00	1.00	0.98	1.00	1.00	0.91	0.97	1.00
121 to 180	5500 to 7500	1.00	1.00	1.00	1.00	1.00	1.00	0.93	0.99	1.00

FIGURE 2–62 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 47, 59 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

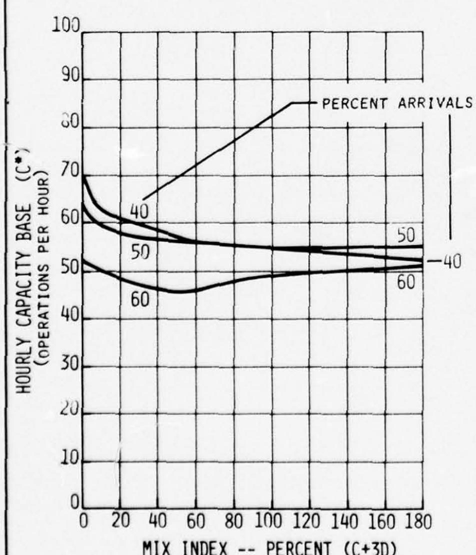
To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	1.00
21 to 50	3000 to 5500	1.00	1.00	1.00	0.97	1.00	1.00	0.91	1.00	1.00
51 to 80	3500 to 6500	1.00	1.00	1.00	0.94	1.00	1.00	0.92	0.99	1.00
81 to 120	5000 to 7000	1.00	1.00	1.00	0.98	1.00	1.00	0.91	0.97	1.00
121 to 180	5500 to 7500	1.00	1.00	1.00	1.00	1.00	1.00	0.93	0.99	1.00

FIGURE 2–63 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 48, 60 FOR IFR CONDITIONS

HOURLY CAPACITY BASE C*



TOUCH & GO FACTOR T

T = 1.00

C* x T x E = Hourly Capacity

EXIT FACTOR E

To determine Exit Factor E:

1. Determine exit range for appropriate mix index from table below
2. For arrival runways, determine the average number of exits(N) which are: (a) within appropriate exit range, and (b) separated by at least 750 feet
3. If N is 4 or more, Exit Factor = 1.00
4. If N is less than 4, determine Exit Factor from table below for appropriate mix index and percent arrivals

Mix Index-- Percent (C+3D)	Exit Range (Feet from threshold)	EXIT FACTOR E								
		40% Arrivals			50% Arrivals			60% Arrivals		
		N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3	N=0	N=1	N=2 or 3
0 to 20	2000 to 4000	0.81	0.91	0.96	0.83	0.95	0.99	0.92	1.00	1.00
21 to 50	3000 to 5500	0.79	0.86	0.92	0.77	0.85	0.92	0.89	0.98	1.00
51 to 80	3500 to 6500	0.81	0.87	0.93	0.77	0.83	0.91	0.90	0.98	1.00
81 to 120	5000 to 7000	1.00	1.00	1.00	0.98	1.00	1.00	0.91	0.97	1.00
121 to 180	5500 to 7500	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.99	1.00

FIGURE 2–64 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 53 FOR IFR CONDITIONS

FIGURE 2–65A

RUNWAY OPERATIONS RATE
0 TO 35 OPERATIONS PER HOUR

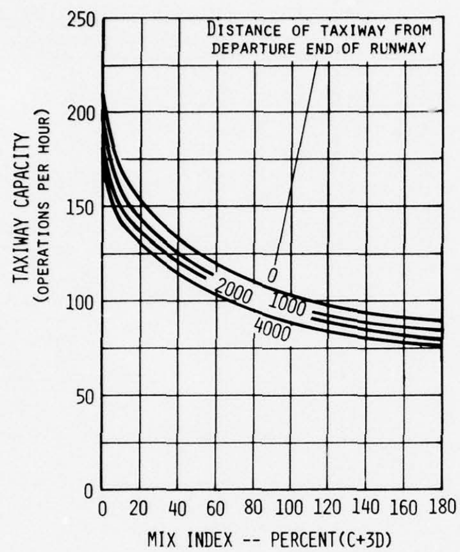


FIGURE 2–65B

RUNWAY OPERATIONS RATE
36 TO 55 OPERATIONS PER HOUR

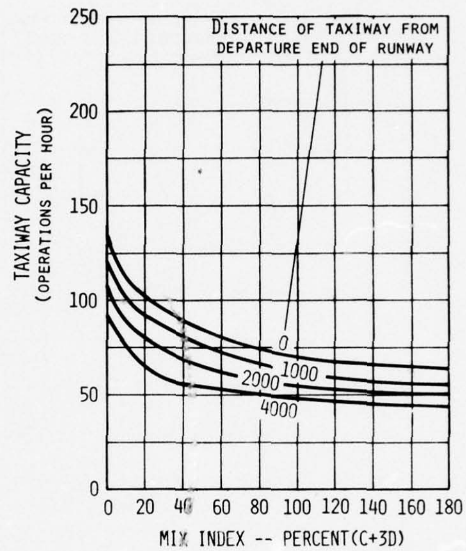


FIGURE 2–65C

RUNWAY OPERATIONS RATE
56 TO 75 OPERATIONS PER HOUR

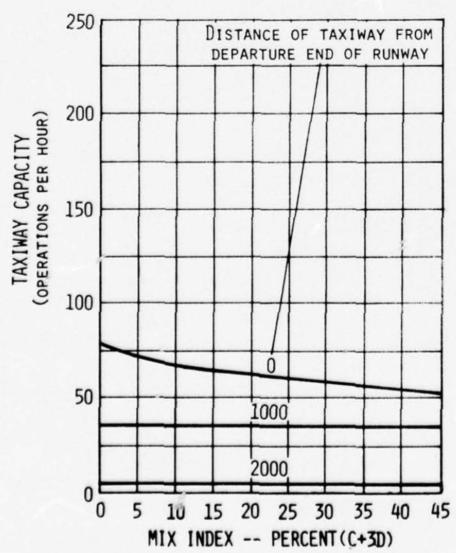


FIGURE 2–65D

RUNWAY OPERATIONS RATE
76 to 95 OPERATIONS PER HOUR

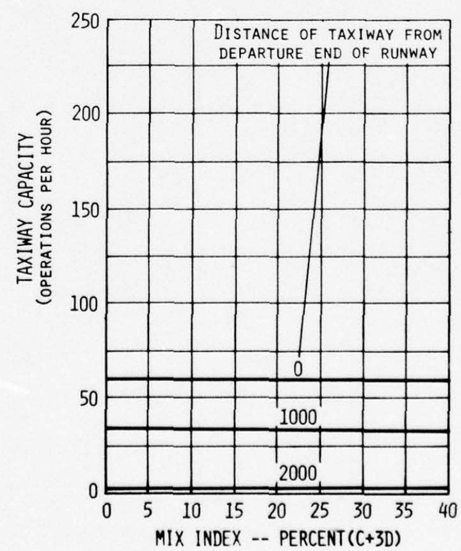


FIGURE 2–65 HOURLY CAPACITY OF A TAXIWAY CROSSING AN ACTIVE RUNWAY WITH ARRIVALS ONLY OR MIXED OPERATIONS

FIGURE 2-66A

RUNWAY OPERATIONS RATE
0 TO 35 OPERATIONS PER HOUR

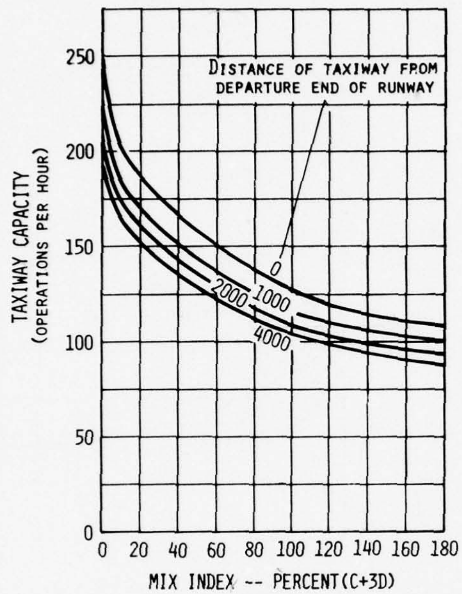


FIGURE 2-66B

RUNWAY OPERATIONS RATE
36 TO 55 OPERATIONS PER HOUR

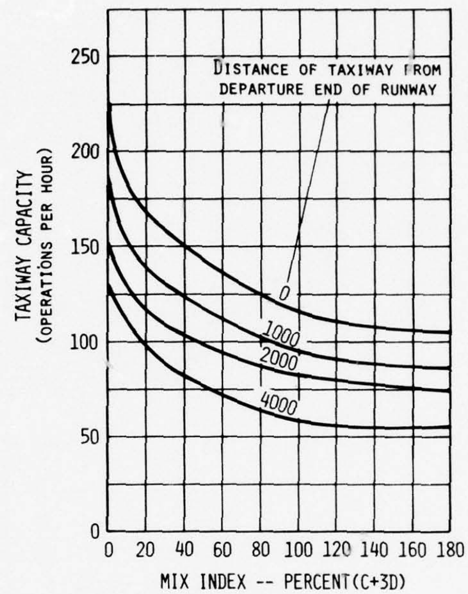


FIGURE 2-66C

RUNWAY OPERATIONS RATE
56 TO 75 OPERATIONS PER HOUR

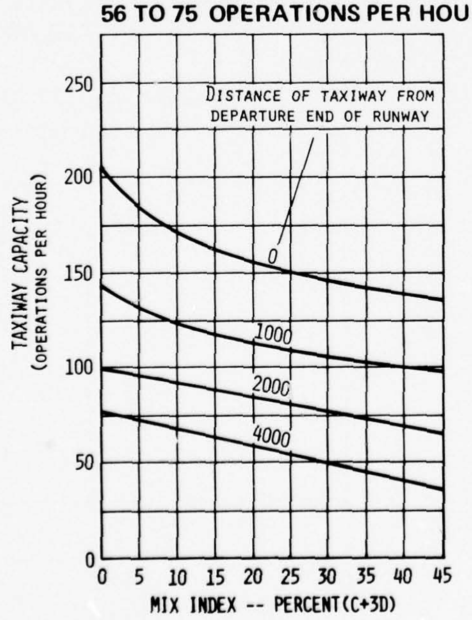


FIGURE 2-66D

RUNWAY OPERATIONS RATE
76 TO 95 OPERATIONS PER HOUR

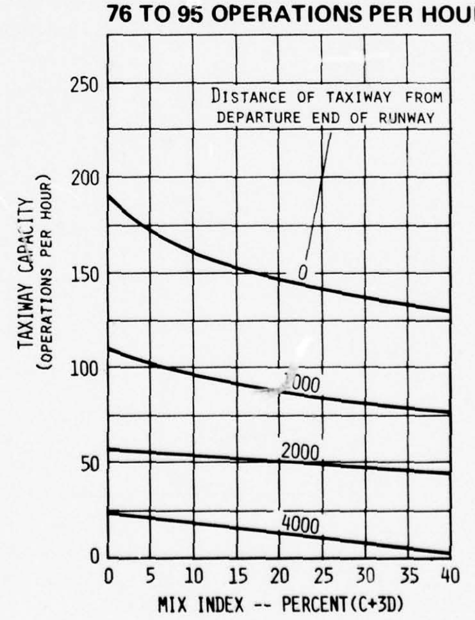
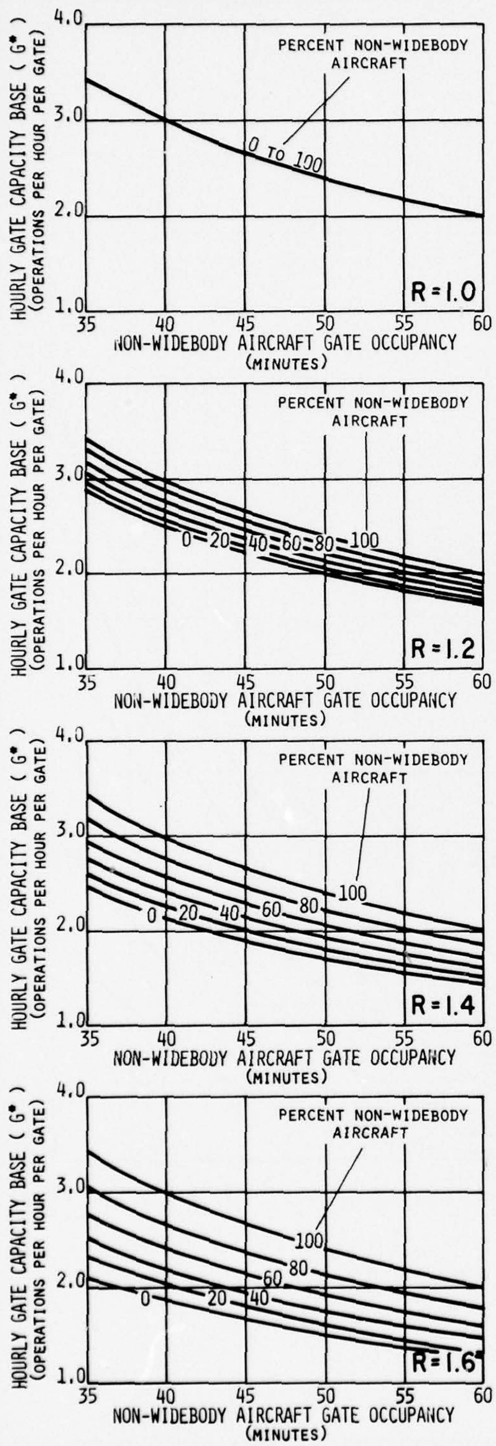
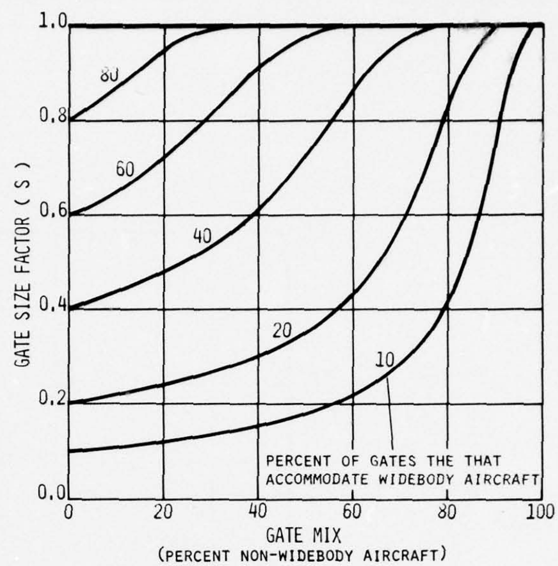


FIGURE 2-66 HOURLY CAPACITY OF A TAXIWAY CROSSING AN ACTIVE RUNWAY WITHOUT ARRIVALS





$G^* \times S \times N$ = Hourly Capacity

NUMBER OF GATES (N)

NOTES:

(1) $R = \dfrac{\left[\text{AVERAGE GATE OCCUPANCY TIME FOR WIDEBODY AIRCRAFT}\right]}{\left[\text{AVERAGE GATE OCCUPANCY TIME FOR NON-WIDEBODY AIRCRAFT}\right]}$

(2) IF OPERATIONS DO NOT INCLUDE WIDEBODY AIRCRAFT, GATE MIX = 100 AND R = 1.0

FIGURE 2–67 HOURLY CAPACITY OF GATES

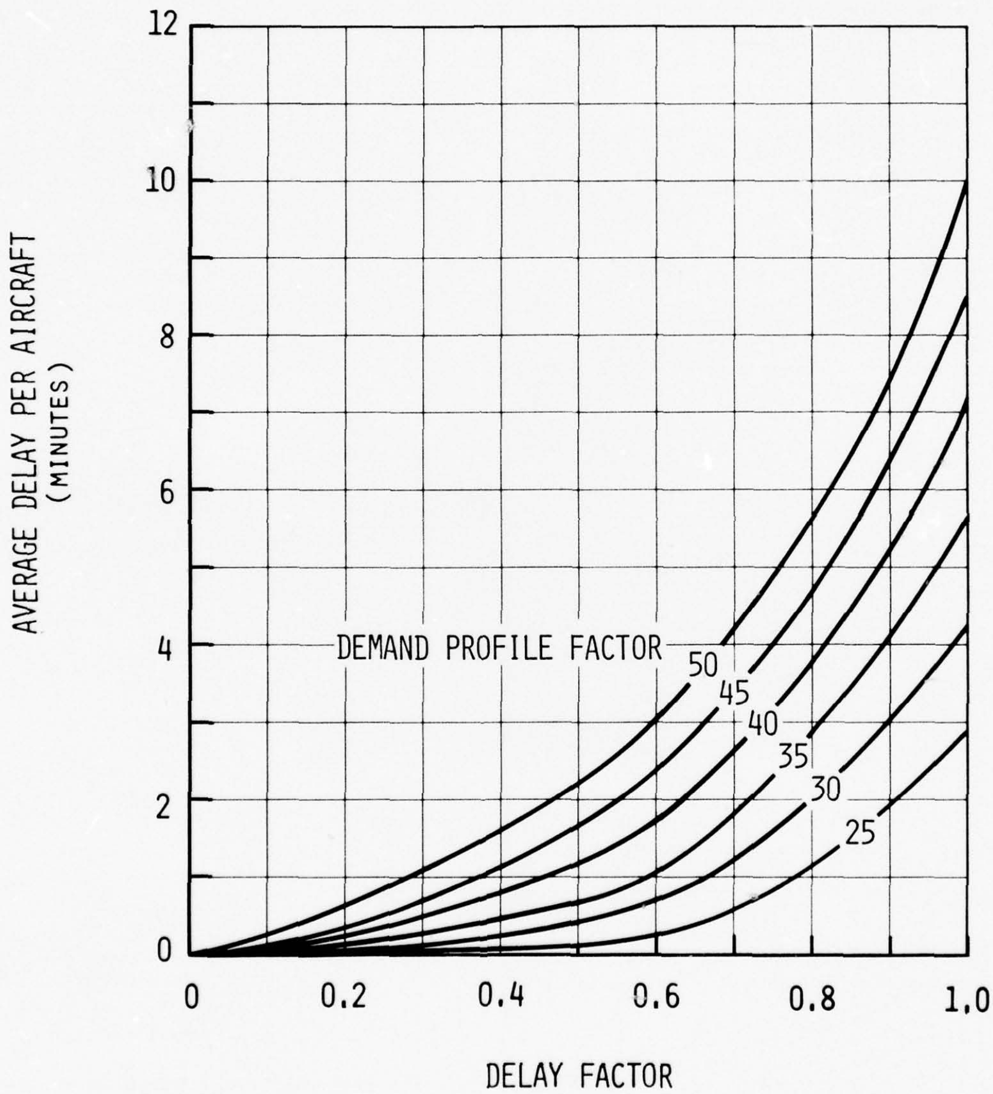
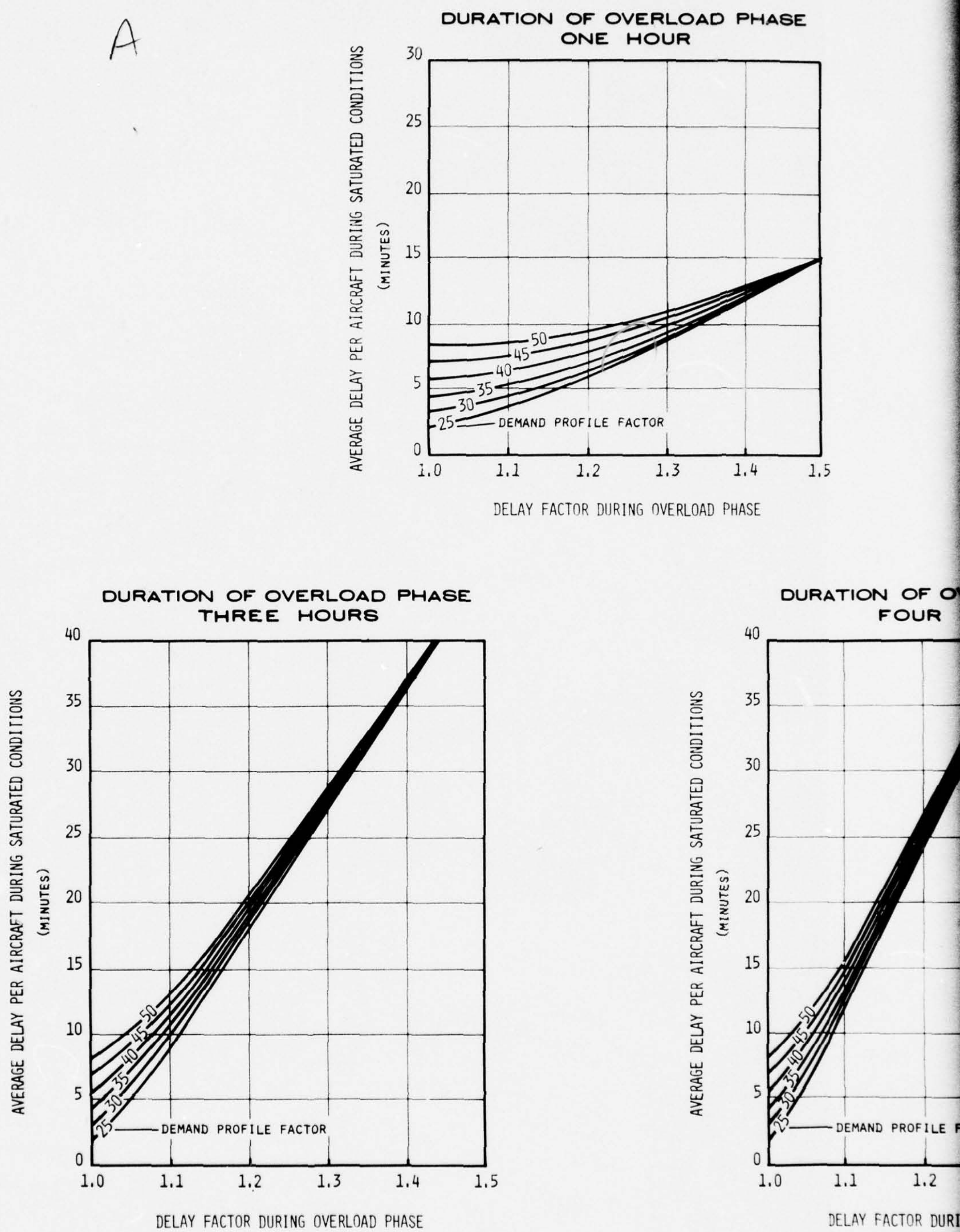


FIGURE 2-68 AVERAGE AIRCRAFT DELAY IN AN HOUR

A

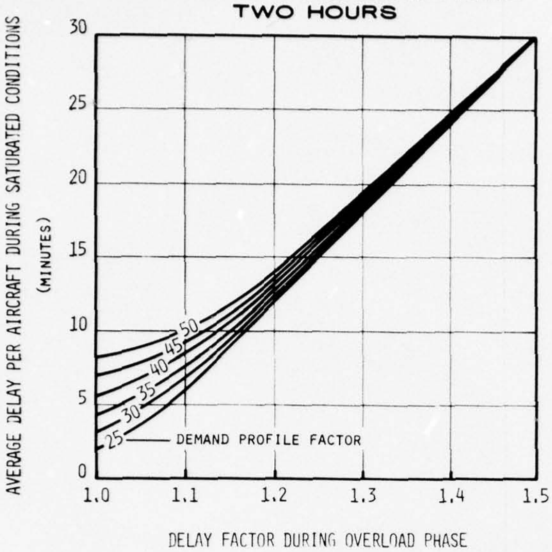


(NOTE: FOR DISCUSSION AND EXAMPLES OF THE TERMS "OVERLOAD PHASE" AND "SATURATED PERIODS", SEE PARAGRAPH 28.C ON PAGE 59.)

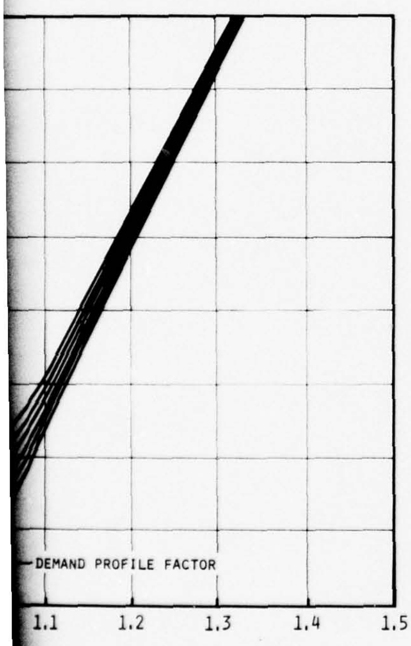
FIGURE 2–69 AVERAGE AIRCRAFT DE

B

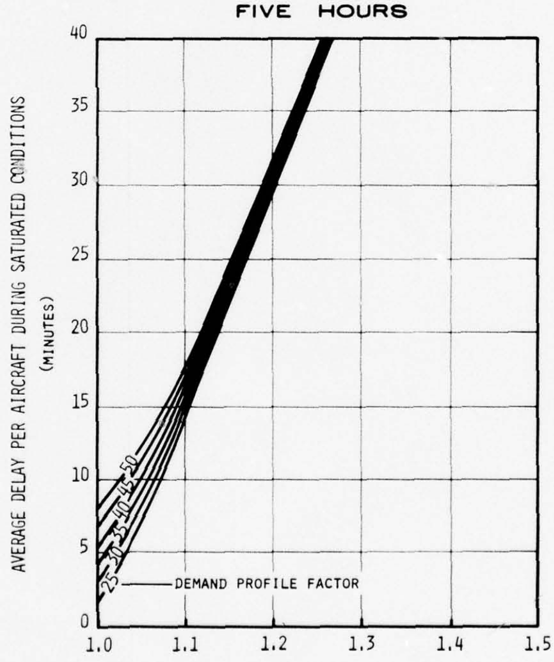
DURATION OF OVERLOAD PHASE
TWO HOURS



RATION OF OVERLOAD PHASE
FOUR HOURS



DURATION OF OVERLOAD PHASE
FIVE HOURS



IRCRAFT DELAY DURING SATURATED CONDITIONS

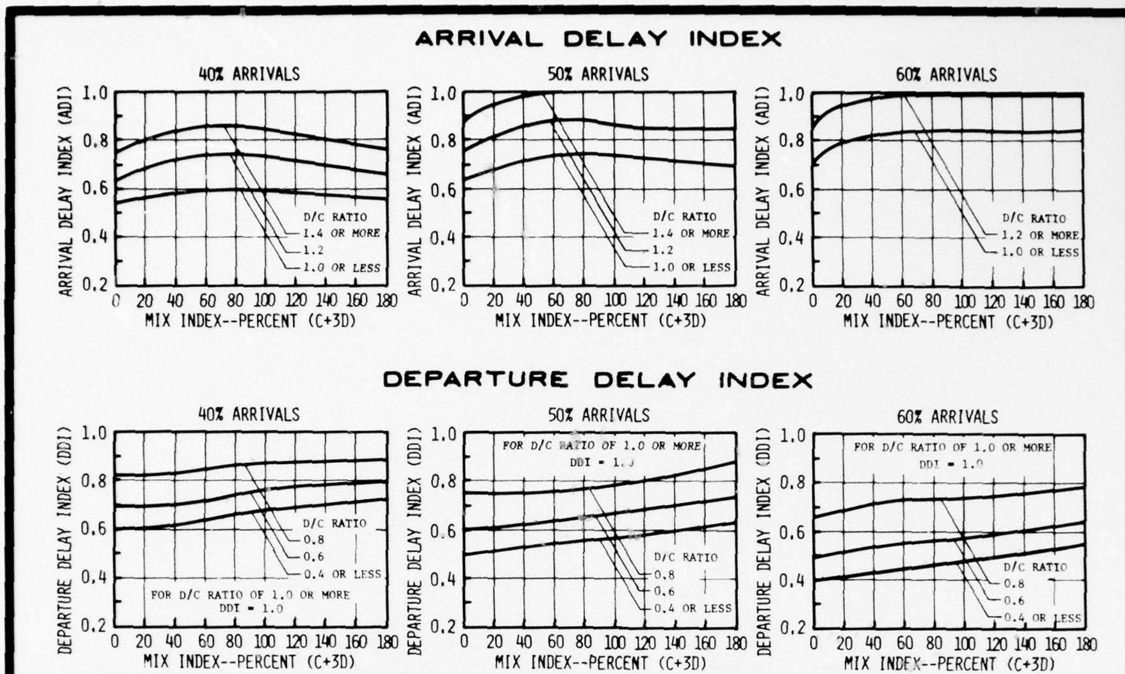


FIGURE 2-70 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 1, 9, 10, 11, 12, 30, 31, 42, 47, 48, 53, 54, 66, 68, 69, 70,71 FOR VFR CONDITIONS

ARRIVAL DELAY INDEX = 1.00

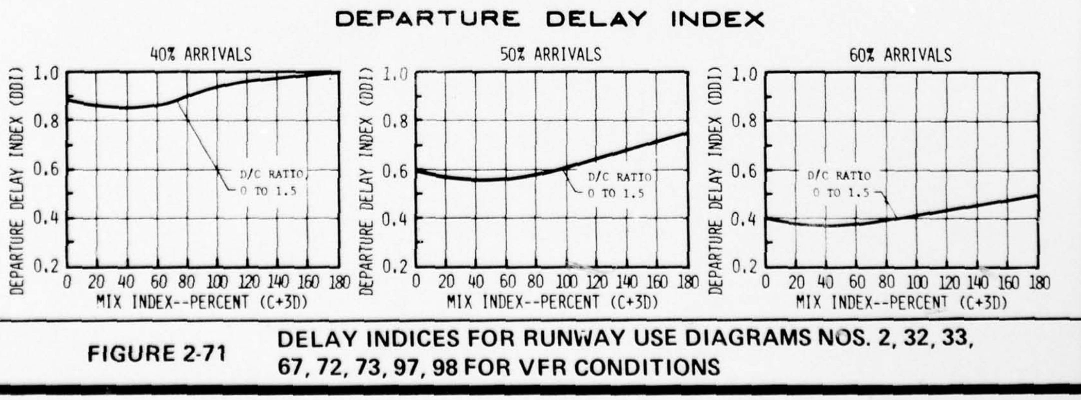


FIGURE 2-71 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 2, 32, 33, 67, 72, 73, 97, 98 FOR VFR CONDITIONS

ARRIVAL DELAY INDEX = 1.00

DEPARTURE DELAY INDEX

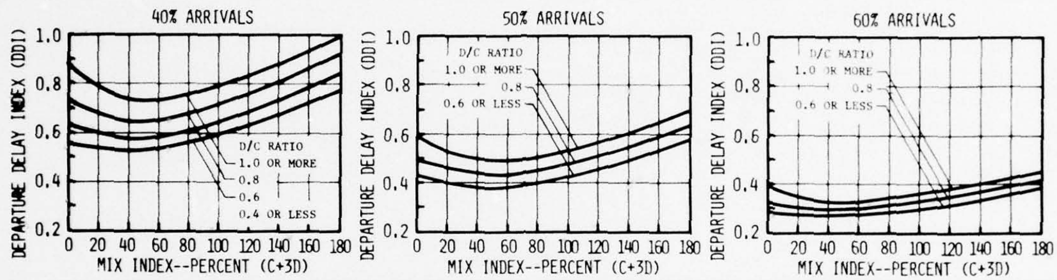


FIGURE 2-72 DELAY INDICES FOR RUNWAY USE DIAGRAM NO. 3 FOR VFR CONDITIONS

ARRIVAL DELAY INDEX = 1.00

DEPARTURE DELAY INDEX

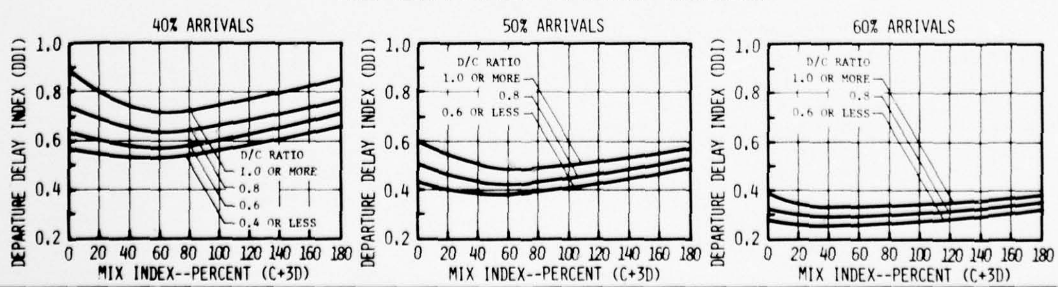
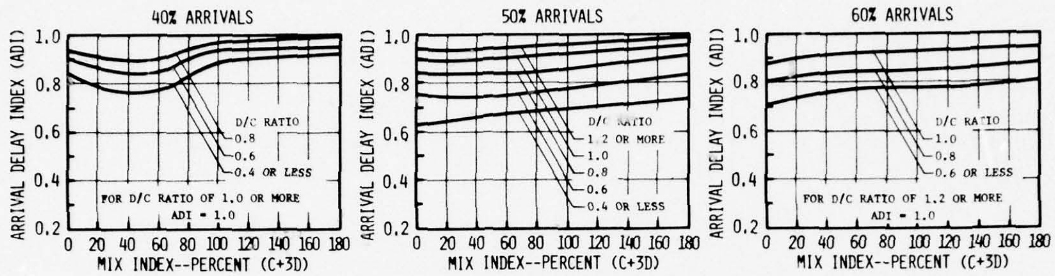


FIGURE 2-73 DELAY INDICES FOR RUNWAY USE DIAG. NOS. 4, 5, 74, 75, 76, 77, 78, 94, 95, 96, 99, 100, 101, 102, 103, 119, 120, 121 FOR VFR CONDITIONS

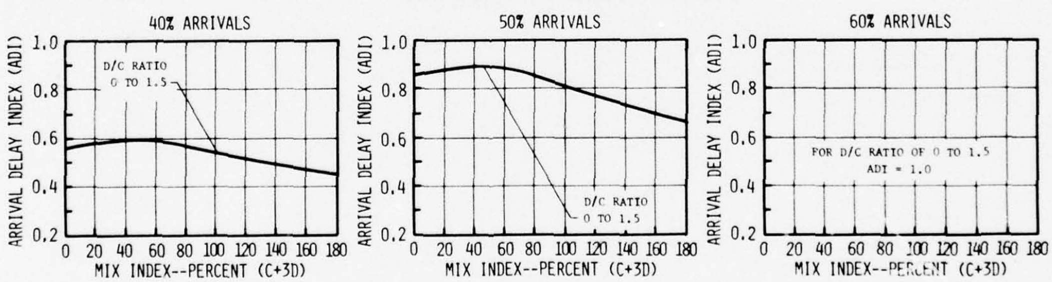
ARRIVAL DELAY INDEX



DEPARTURE DELAY INDEX = 1.00

FIGURE 2-74 **DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 6, 7, 8, 79, 104 FOR VFR CONDITIONS**

ARRIVAL DELAY INDEX



DEPARTURE DELAY INDEX

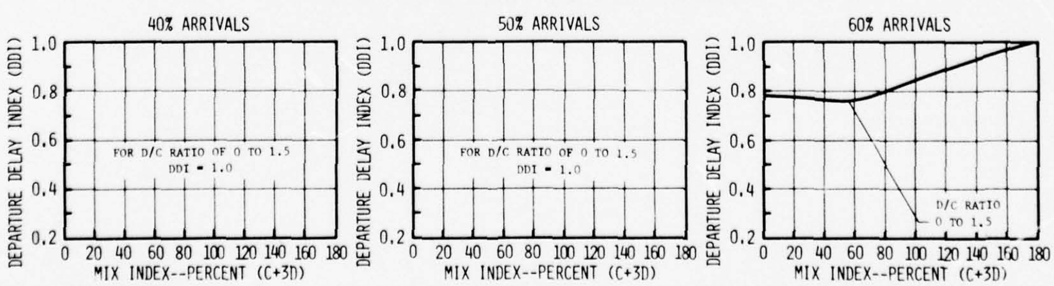


FIGURE 2-75 **DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 13, 14 FOR VFR CONDITIONS**

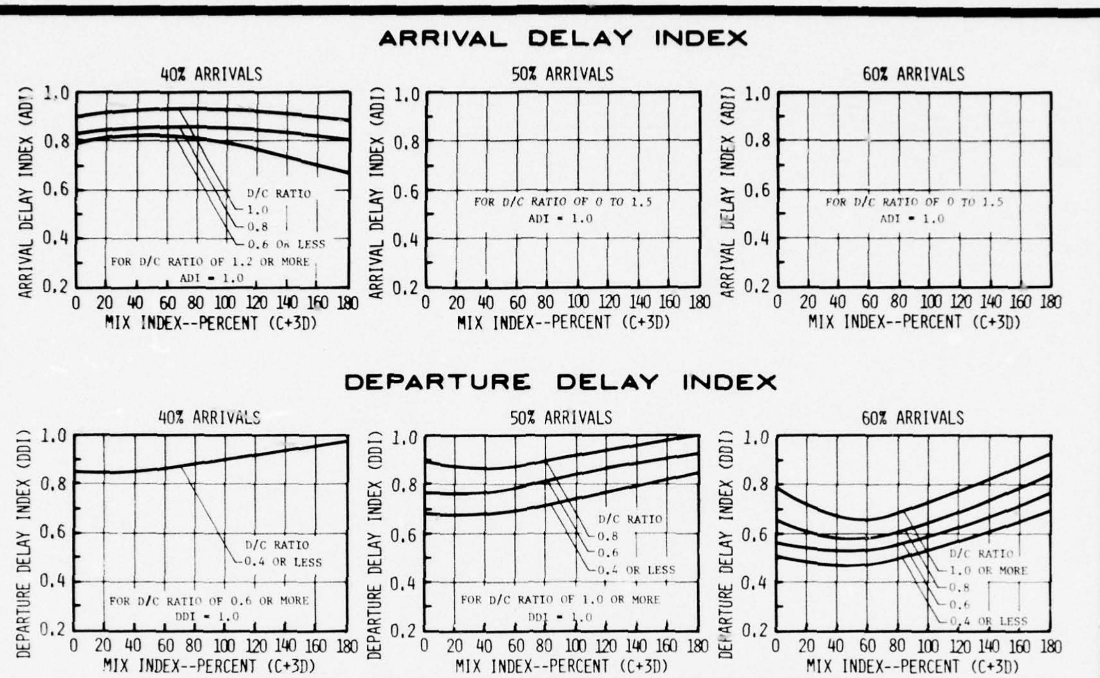


FIGURE 2-76	DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 15, 85, 110 FOR VFR CONDITIONS

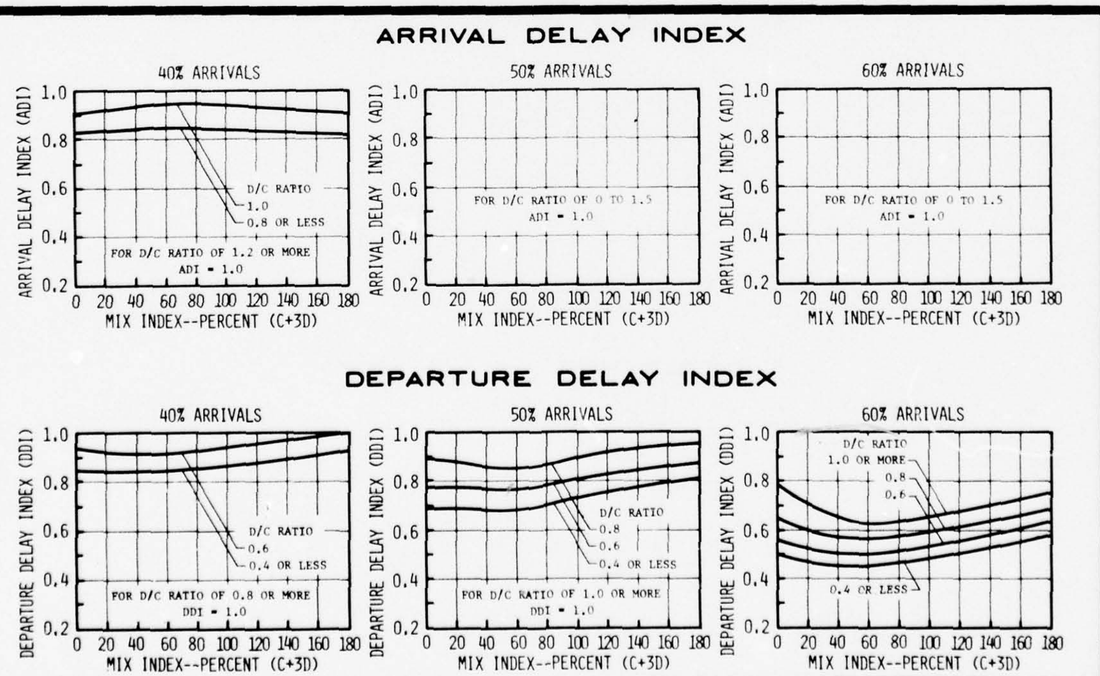


FIGURE 2-77	DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 16, 17, 18, 19, 20, 21, 22, 80, 81, 82, 83, 84, 105, 106, 107, 108, 109 FOR VFR CONDITIONS

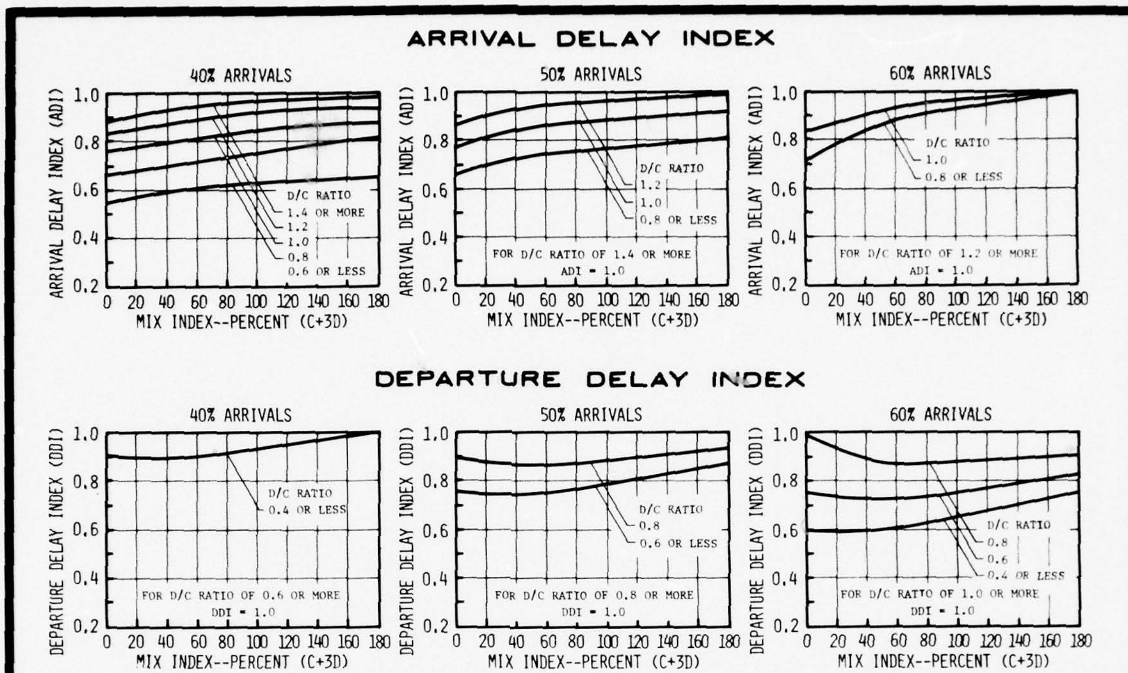


FIGURE 2-78 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 23, 26 FOR VFR CONDITIONS

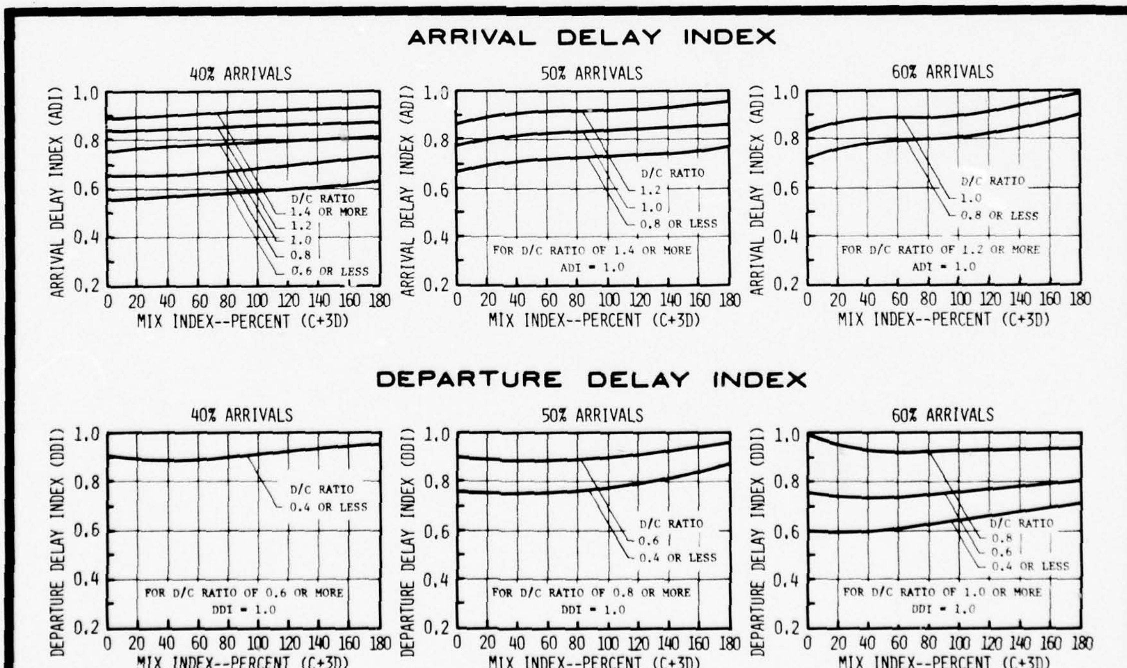


FIGURE 2-79 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 24, 25, 27, 28, 41, 91, 116 FOR VFR CONDITIONS

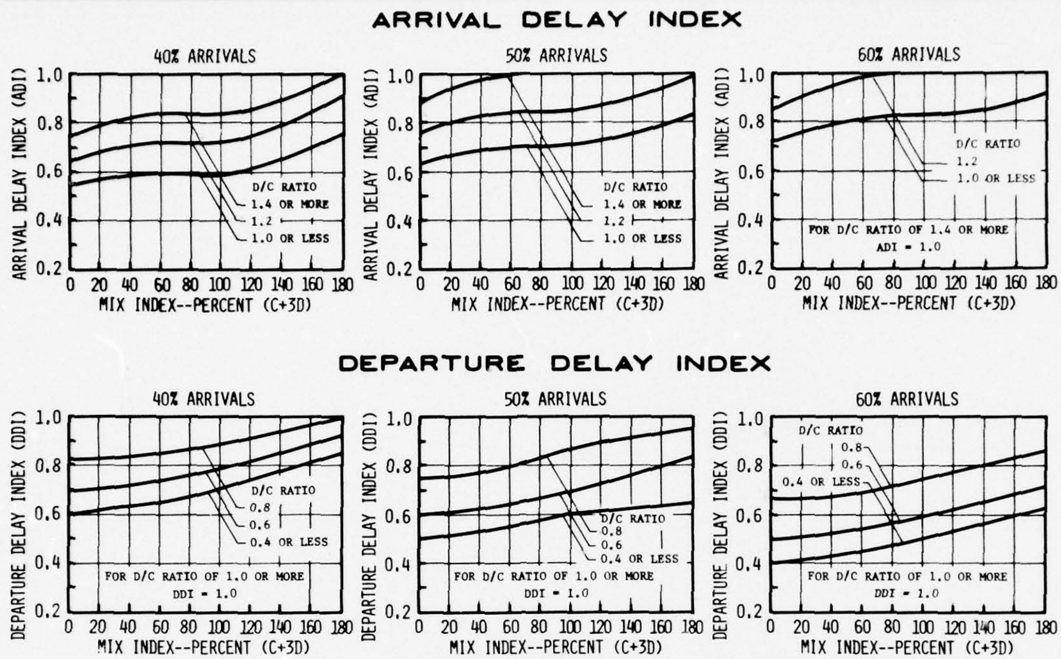


FIGURE 2-80 DELAY INDICES FOR RUNWAY USE DIAGRAM NO. 29 FOR VFR CONDITIONS

ARRIVAL DELAY INDEX = 1.00

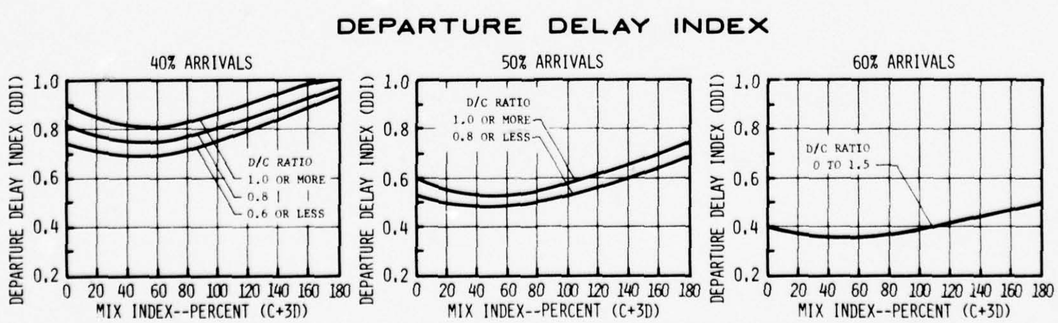


FIGURE 2-81 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 34, 35 FOR VFR CONDITIONS

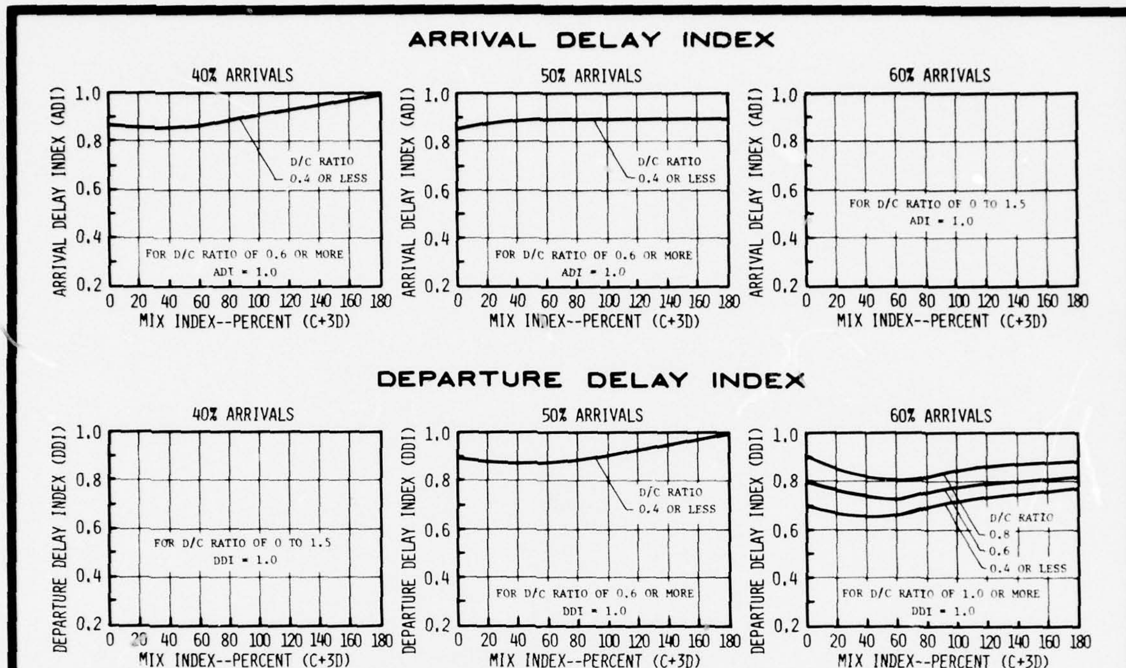


FIGURE 2-82 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 36, 37, 38 FOR VFR CONDITIONS

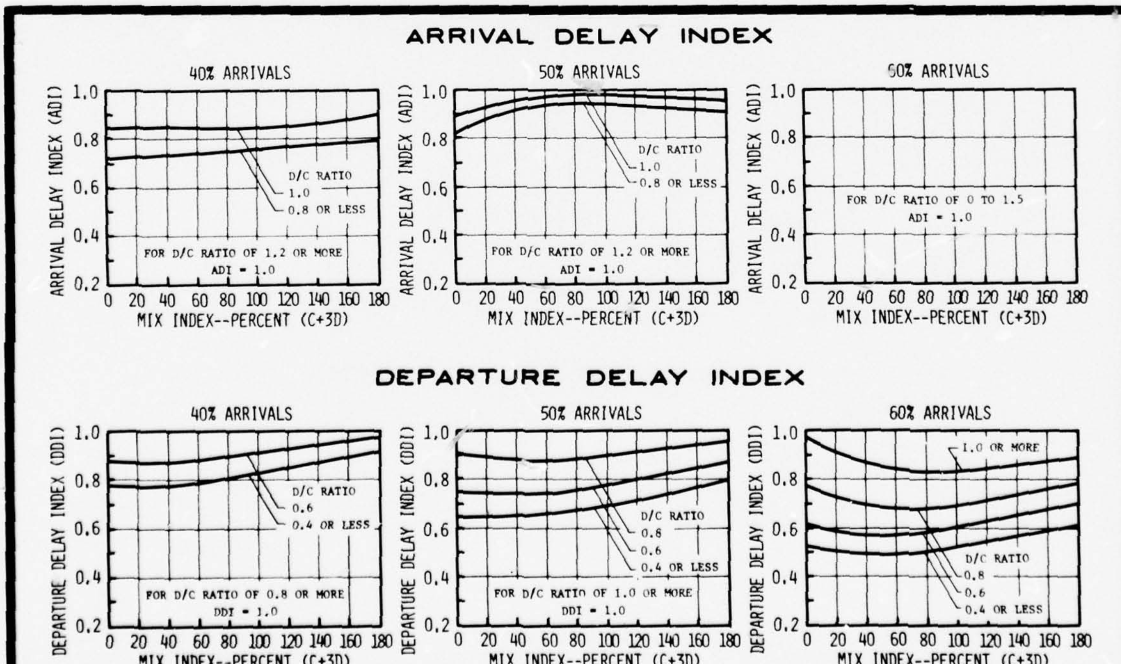


FIGURE 2-83 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 39, 40 VFR CONDITIONS

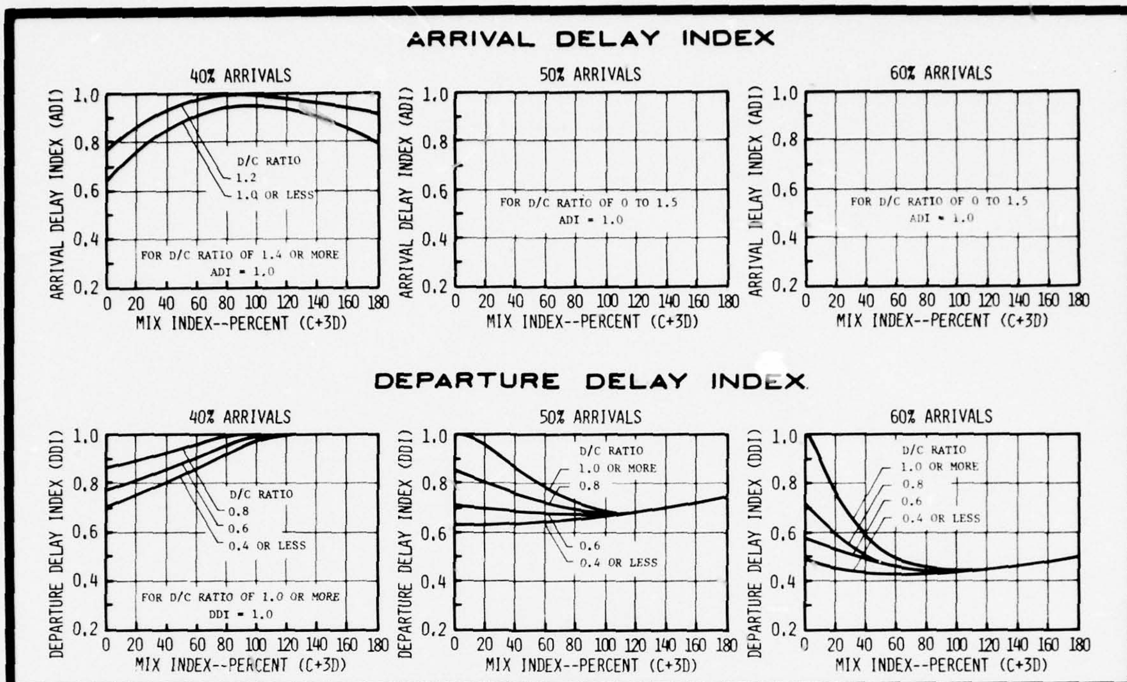


FIGURE 2-84 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 43, 49, 55, 61 FOR VFR CONDITIONS

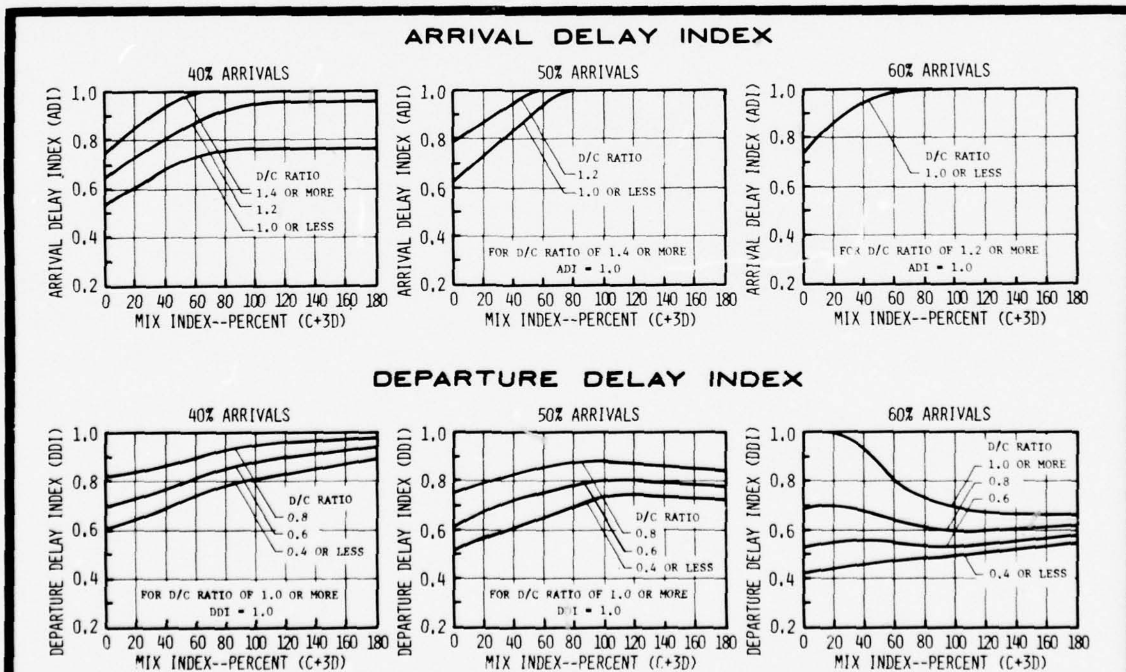


FIGURE 2–85 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 44, 45, 46, 50, 51, 52, 56, 57, 58, 62, 63, 64 FOR VFR CONDITIONS

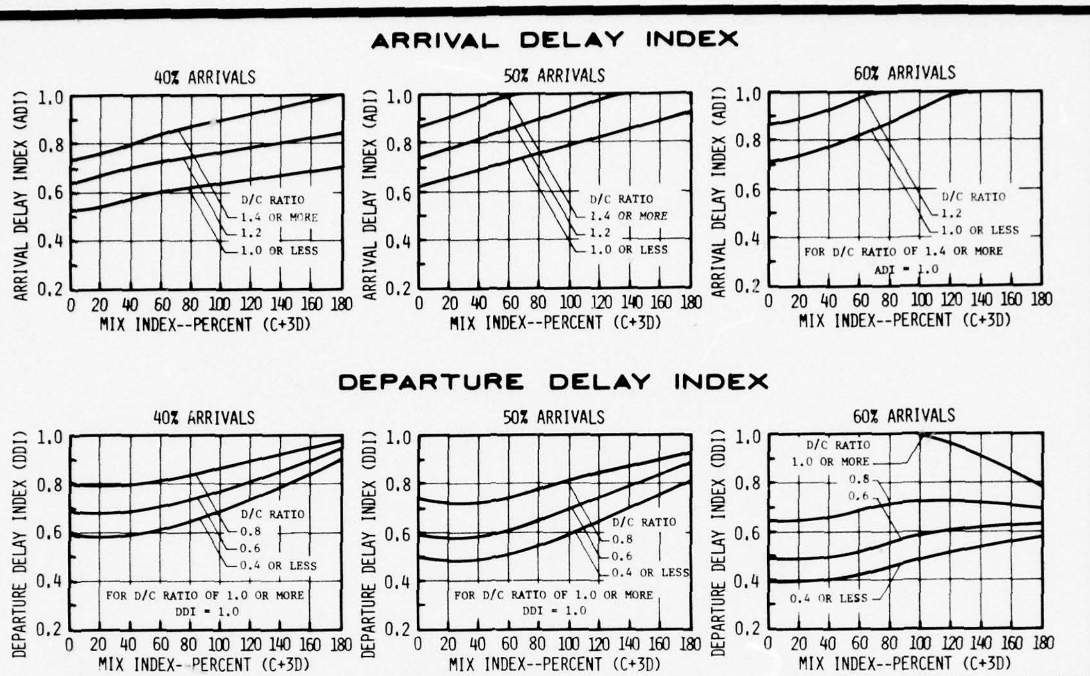


FIGURE 2-86 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 59, 60, 65 FOR VFR CONDITIONS

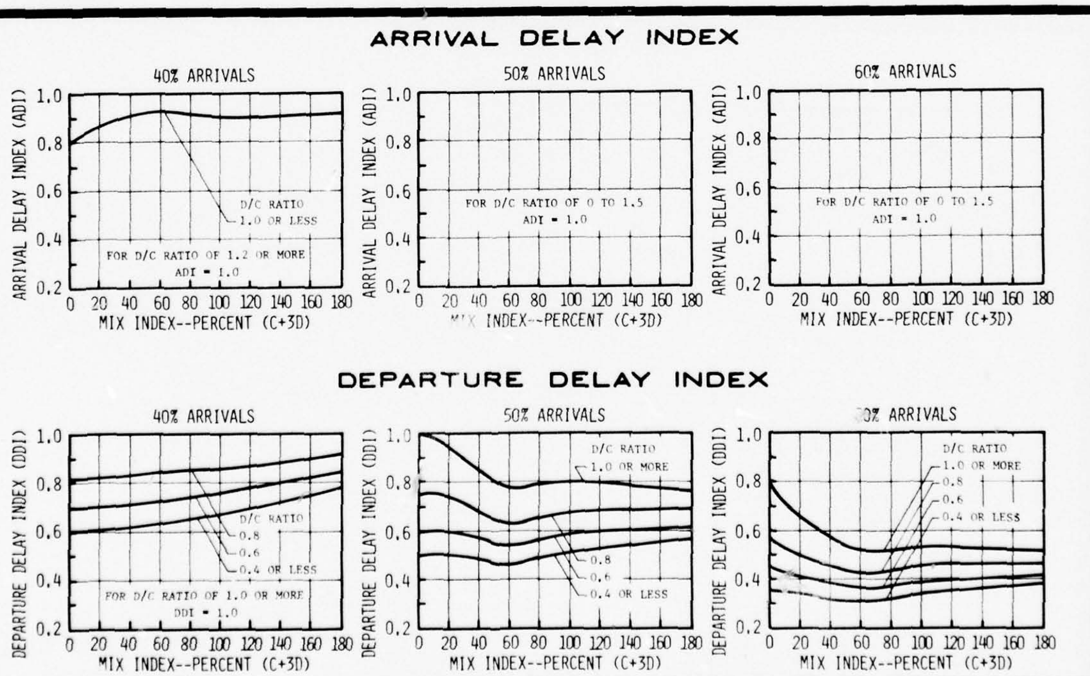


FIGURE 2-87 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 86, 87, 88, 89, 90, 111, 112, 113, 114, 115 FOR VFR CONDITIONS

ARRIVAL DELAY INDEX = 1.00

DEPARTURE DELAY INDEX

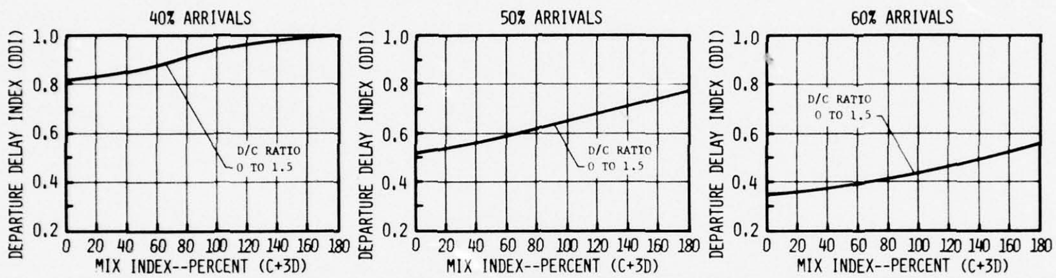
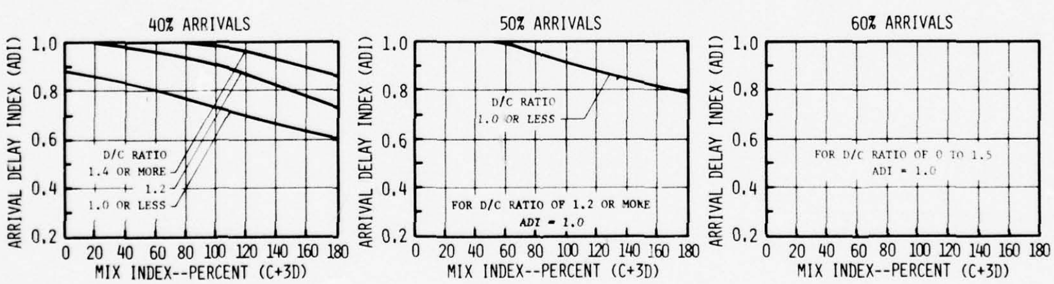


FIGURE 2-88 **DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 92, 93, 117, 118, 122 FOR VFR CONDITIONS**

ARRIVAL DELAY INDEX



DEPARTURE DELAY INDEX

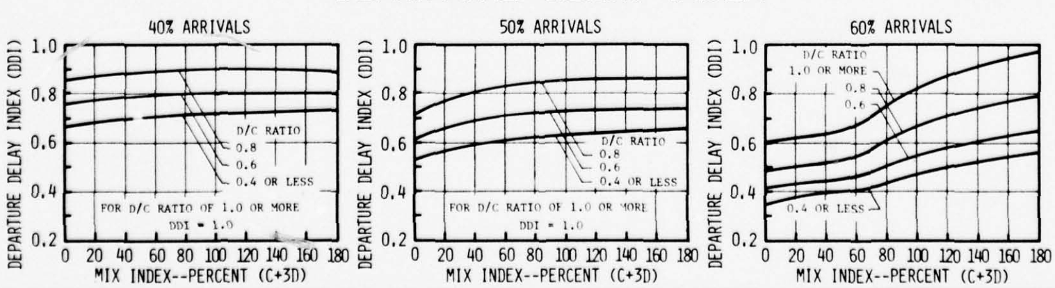


FIGURE 2–89 **DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 1, 53, 54 FOR IFR CONDITIONS**

ARRIVAL DELAY INDEX = 1.00

DEPARTURE DELAY INDEX

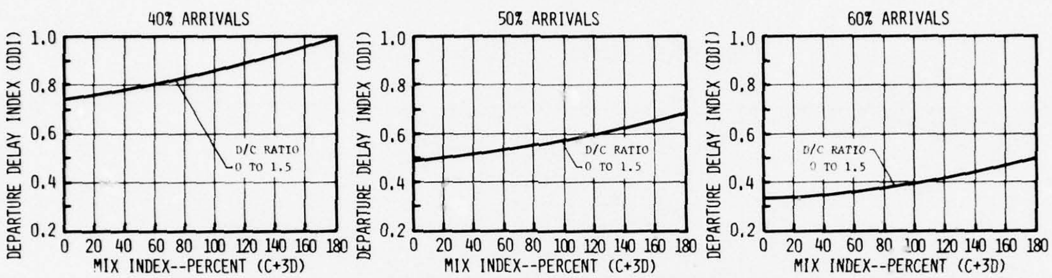


FIGURE 2-90 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 2, 3, 4, 6, 9, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 49, 55, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 76, 79, 85, 91, 92, 93, 97, 98, 99, 101, 104, 110, 116, 117, 118, 122 FOR IFR CONDITIONS

ARRIVAL DELAY INDEX = 1.00

DEPARTURE DELAY INDEX

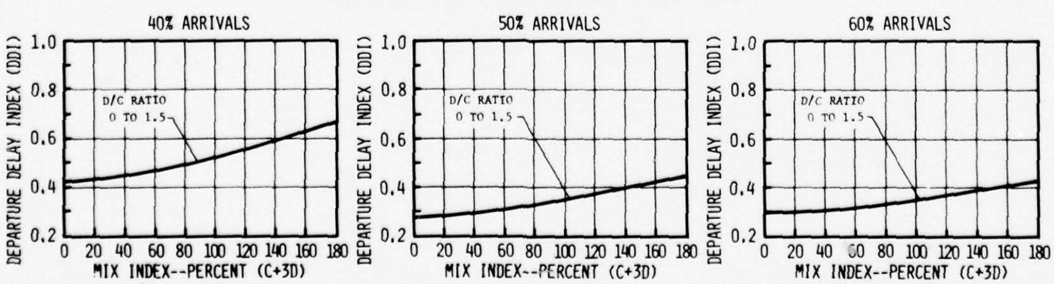


FIGURE 2-91 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 5, 19, 30, 75, 77, 78, 100, 102, 103 FOR IFR CONDITIONS

ARRIVAL DELAY INDEX = 1.00

DEPARTURE DELAY INDEX

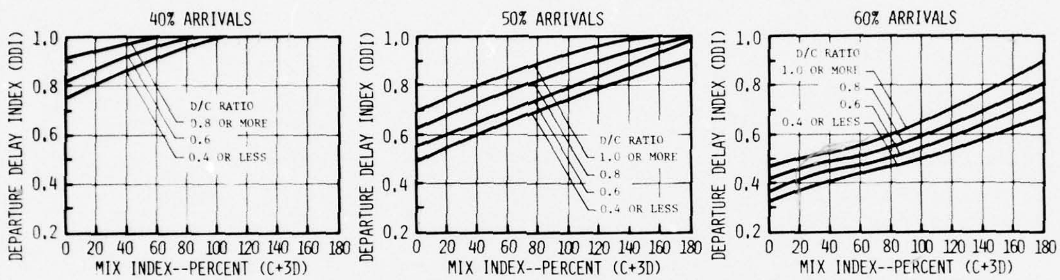
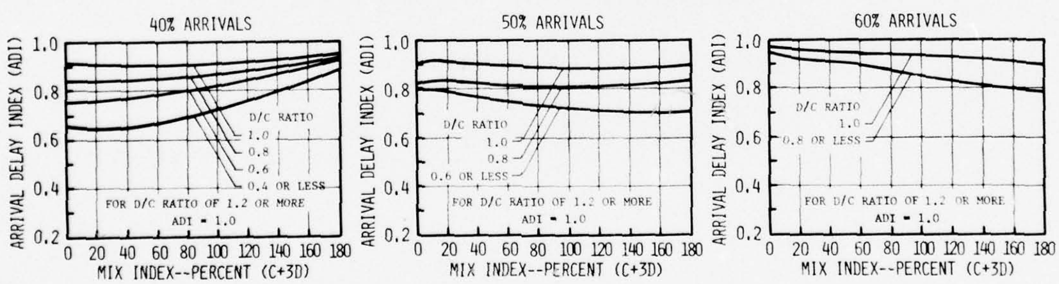


FIGURE 2-92 DELAY INDICES FOR RUNWAY USE DIAGRAM NO. 7 FOR IFR CONDITIONS

ARRIVAL DELAY INDEX



DEPARTURE DELAY INDEX

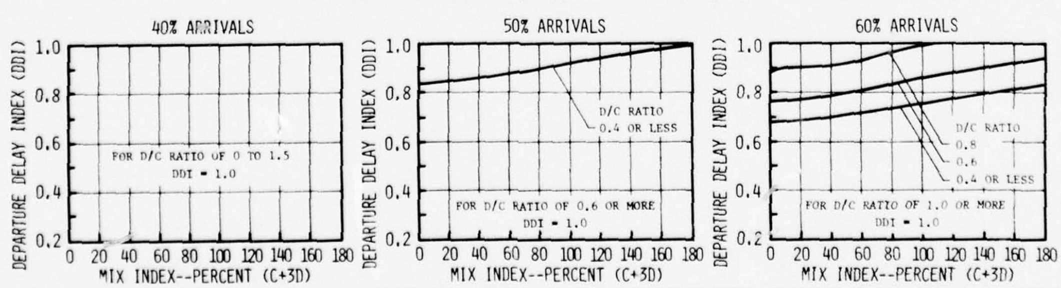


FIGURE 2-93 DELAY INDICES FOR RUNWAY USE DIAGRAM NO. 8 FOR IFR CONDITIONS

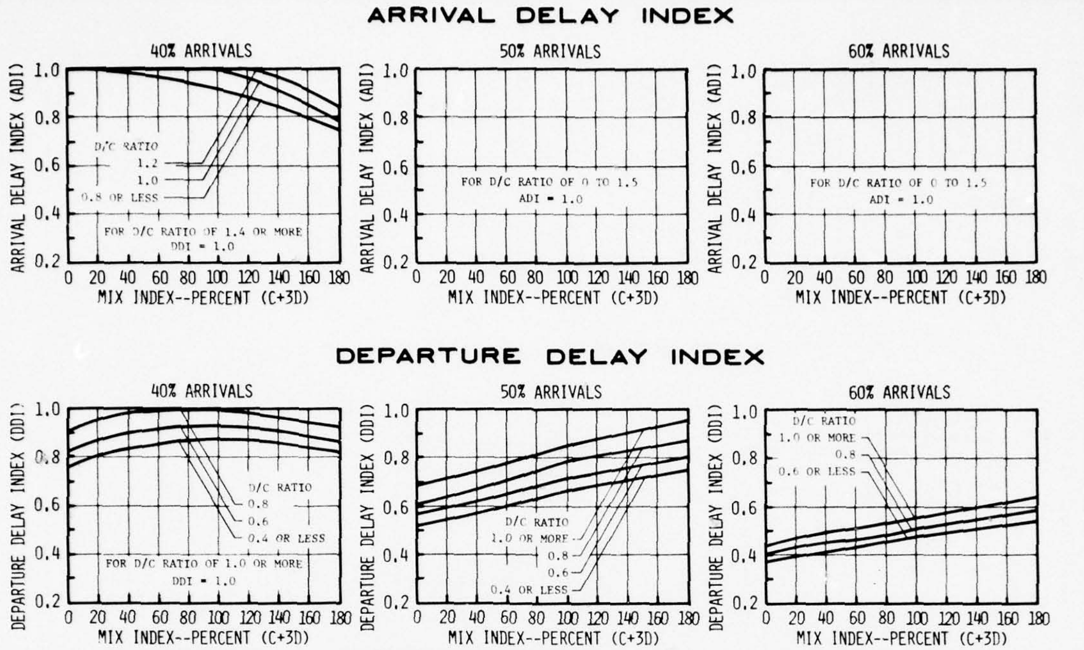


FIGURE 2-94 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 10, 29, 69 FOR IFR CONDITIONS

ARRIVAL DELAY INDEX = 1.00

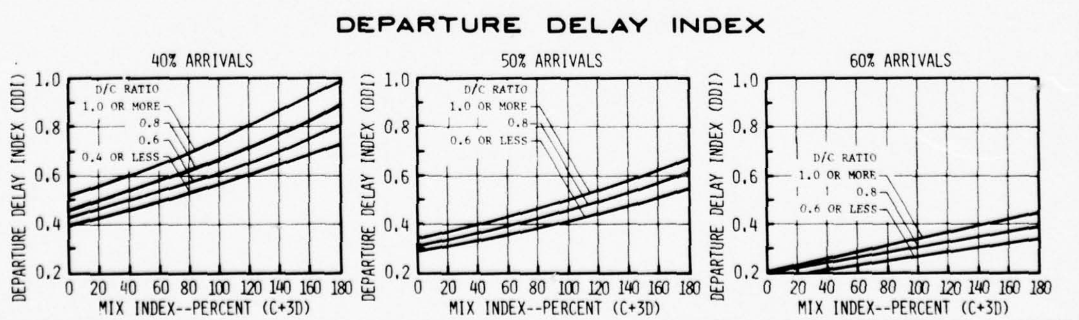


FIGURE 2-95 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 11, 70 FOR IFR CONDITIONS

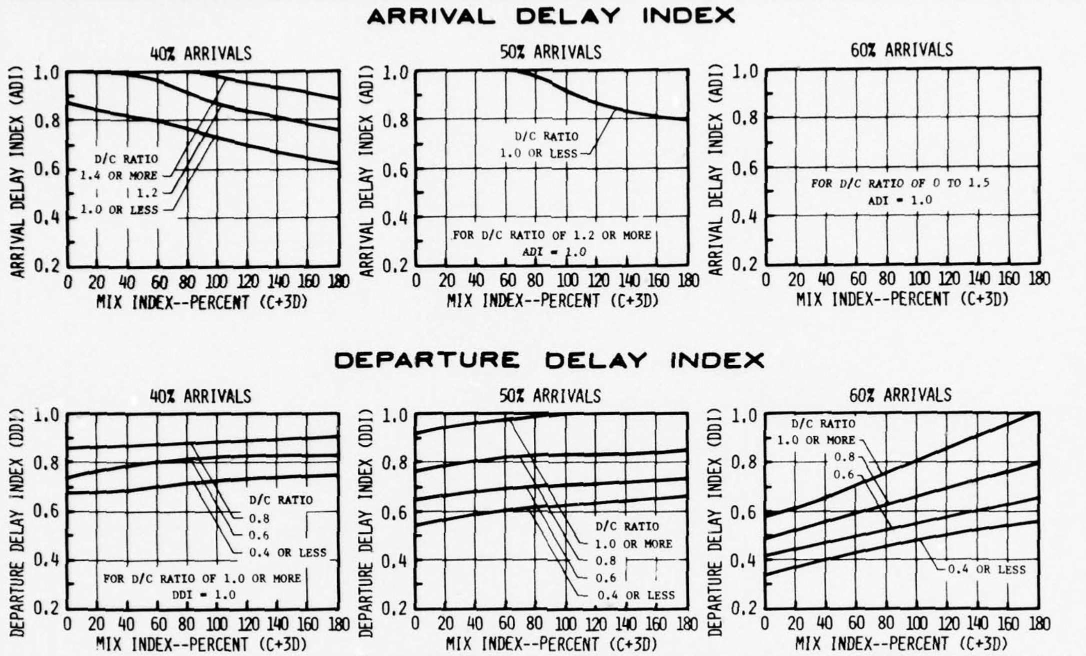


FIGURE 2-96 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 12, 71 FOR IFR CONDITIONS

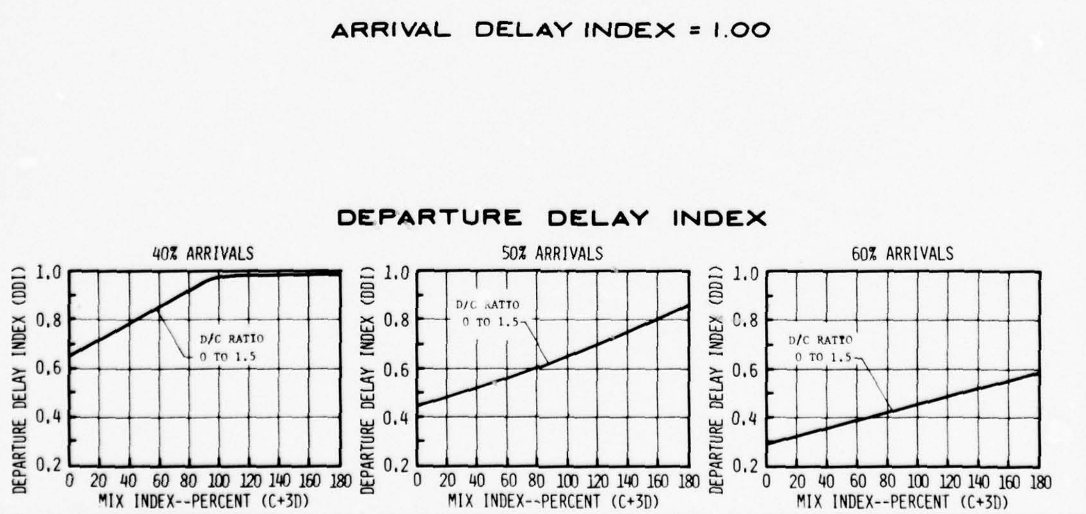


FIGURE 2-97 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 13, 15, 16, 23, 24, 26, 27 FOR IFR CONDITIONS

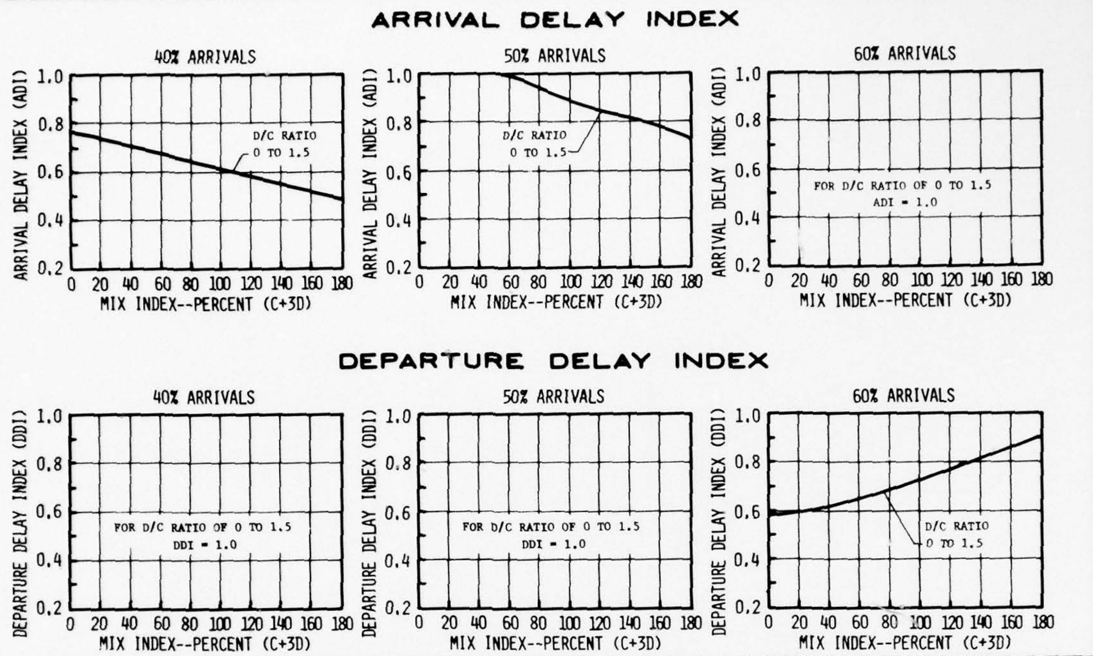


FIGURE 2-98 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 14, 28 FOR IFR CONDITIONS

ARRIVAL DELAY INDEX = 1.00

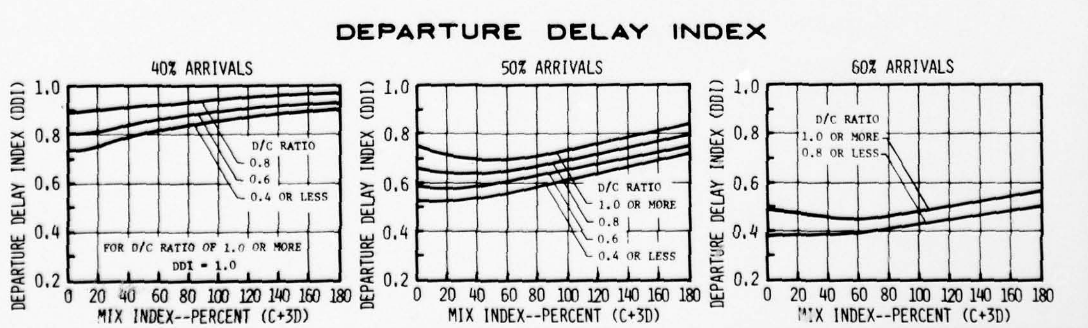


FIGURE 2-99 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 17, 20, 25, 31, 36, 44, 45, 46, 50, 51, 52, 56, 57, 58 FOR IFR CONDITIONS

ARRIVAL DELAY INDEX = 1.00

DEPARTURE DELAY INDEX

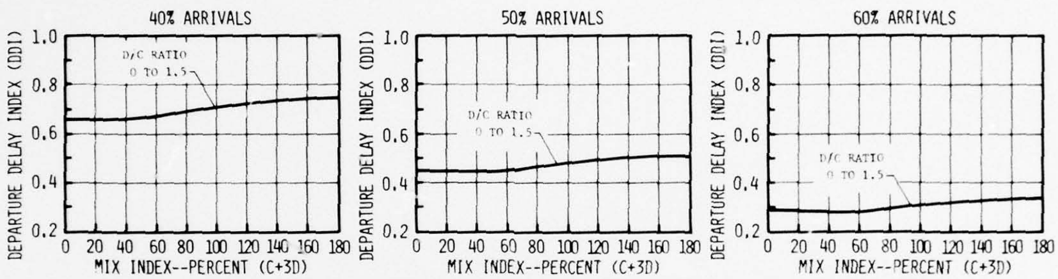


FIGURE 2-100 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 18, 21, 80, 82, 86, 88, 94, 105, 107, 111, 113, 119 FOR IFR CONDITIONS

ARRIVAL DELAY INDEX = 1.00

DEPARTURE DELAY INDEX

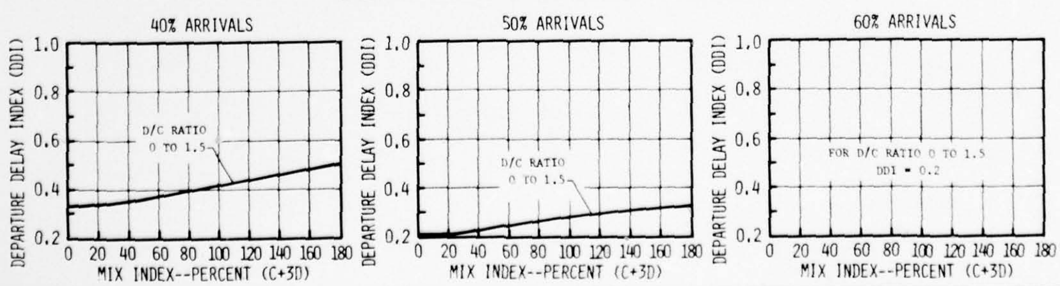


FIGURE 2-101 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 22, 81, 83, 84, 87, 89, 90, 95, 96, 106, 108, 109, 112, 114, 115, 120, 121 FOR IFR CONDITIONS

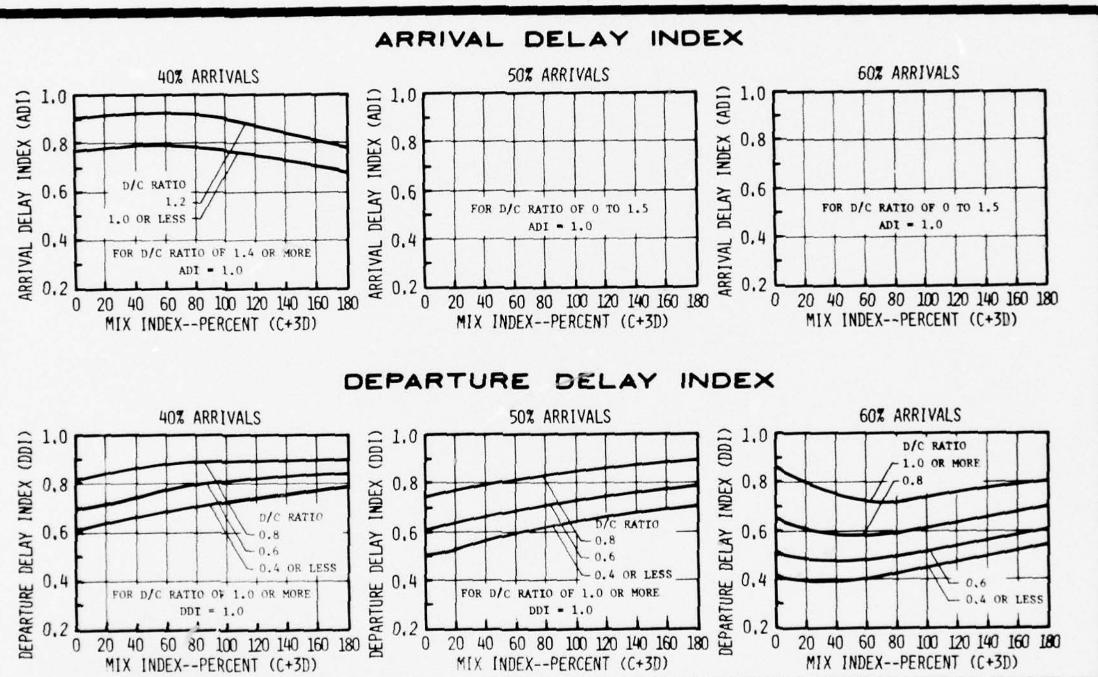


FIGURE 2-102 DELAY INDICES FOR RUNWAY USE DIAGRAMS NOS. 47, 48, 59, 60 FOR IFR CONDITIONS

CHAPTER 3. COMPUTERIZED TECHNIQUES TO DETERMINE HOURLY CAPACITY OF RUNWAYS AND ANNUAL DELAY TO AIRCRAFT

30. GENERAL. This chapter describes computerized techniques for determining the hourly capacity of runways and annual delay to aircraft on runways. The computerized techniques require a remote teletype terminal and a telephone connection with a company offering the techniques; the techniques do not require a detailed understanding of computer operations or computer programs.

The computerized techniques employ tutorial procedures where the computer directs the remote terminal to type a data request; the user enters the requested data at the remote terminal; another data request is typed at the remote terminal; etc. This question and answer sequence is repeated until the user has entered all the required data. The computer then computes the hourly capacity or annual delay and directs the remote terminal to type the computed value. The computer automatically checks certain input data to determine if they are in a valid format (e.g., the aircraft mix percentages must sum to 100) and requests new data be entered if the format of the original data is invalid.

The computerized technique for determining the hourly capacity of runways permits direct access to the computer program used to produce the runway capacity charts in Chapter 2. In addition, the technique was designed to offer the following capabilities not offered in Chapter 2.

- Any percent arrivals from 0% to 100%
- Future air traffic control systems
- Poor visibility and ceiling (PVC) conditions
- Wet runway conditions

The annual delay to aircraft technique is computerized because the manual procedure for computing annual delay in Chapter 2 is a time consuming task involving a lengthy calculation process. Annual delay is the sum of daily delay for all 365 days. The computerized annual delay technique accommodates seasonal, daily, and hourly variations in demand and capacity throughout the year by considering the percent of annual operations in each month, the percent of each week's operations in each day, and the percent of daily operations in each hour. In

addition, the occurrence of three different conditions (i.e., VFR, IFR, PVC) is considered in combination with as many runway uses as desired.

31. COMPUTER ACCESS AND INPUT GUIDELINES. A complete list of companies offering the computerized hourly runway capacity and annual delay technique can be obtained from:

Chief, Airport Design Branch (ARD-410)
Federal Aviation Administration
2100 Second Street, S.W.
Washington, D.C. 20591
(202) 426-3684

Representatives of companies offering the techniques will explain the remote terminals used (and how to operate them), the telephone number and access procedure, and the computer service charges. Most remote teletype terminals can be used.

The access procedure consists of telephoning the company, connecting the telephone to the remote terminal, typing a user identification number (assigned by the company), and typing the program identification code. (Some companies may modify the access or program termination procedures defined herein; the company representative will define all such program modifications.) The user must pay for computer time, connect time, and other costs associated with use of the program.

Once the computer is accessed, the user can calculate the hourly capacity of runways or the annual delay to aircraft for as many cases as desired without repeating the access procedure. After completing a calculation for hourly capacity or annual delay, the remote terminal automatically types the question DO YOU WISH TO PERFORM ANOTHER CALCULATION? If the user responds with YES or Y, the remote terminal automatically repeats the question and answer procedure for the next case. Any other response will automatically terminate the calculation procedure, and the computer will direct the remote terminal to type information on the computer time used. The user can disconnect the telephone at this time.

The user should adhere to the following guidelines for entering input data for the hourly capacity and the annual delay techniques.

- Enter letters as lower or upper case.
- Correct errors by backspacing and entering the correct data before activating the return key.
- Separate a series of numbers (e.g., exit taxiway locations) by spaces or commas.
- Do not use a comma when entering a number greater than 999 (e.g., enter 1520 instead of 1,520).
- Do not enter more than two numbers to the right of the decimal when entering a percentage (e.g., 17.426 will be read by the computer as 17.42).

If incorrect data (in a valid format) have been entered, the user can enter the word STOP, and the remote terminal will automatically terminate that input dialogue and restart the data request sequence from the beginning.

After computer access, the remote terminal prints the program name, version number, and date of implementation. The version identification is updated if the technique is modified due to significant changes in air traffic control and/or aircraft operating parameters. The companies offering these techniques receive updated versions; hence, only the most current version is available. The examples in this chapter were solved with the following computerized technique versions: hourly runway capacity version 2 (May 1976); and annual delay version 1 (May 1976). Whenever an updated version is implemented, a notice is published to identify any changes in the techniques, instructions, and examples, as well as any appropriate revisions to this report. Detailed information on previous versions can be obtained from:

Chief, Airport Design Branch (ARD-410)
Federal Aviation Administration
2100 Second Street, S.W.
Washington, D.C. 20591
(202) 426-3684

32. <u>COMPUTERIZED TECHNIQUE FOR DETERMINING HOURLY CAPACITY OF RUNWAYS</u>. Figure 3-1[a] summarizes the major elements of the dialogue between the user and the remote terminal for the computerized technique to determine the hourly capacity of runways. The elements are:

- Data request statements made by the remote terminal
- Applicability of the data request statements
- Valid format for the user to enter data
- Error messages typed by the remote terminal if data are entered in an invalid format.

Figure 3-2 depicts the various runway use diagrams used in the computerized technique, and Figure 3-3 is a sample worksheet for the computerized technique to help the user prepare inputs. Even though the inputs can be developed as the data are requested, the worksheet is recommended for first-time use or if several runway use configurations are to be evaluated.

a. <u>Data Requests and Acceptable Inputs</u>. The following is a detailed description of the data requests in Figure 3-1 and the acceptable user inputs.

DO YOU WANT A LISTING AND IMPLEMENTATION SCHEDULE FOR FUTURE ATC SYSTEMS?

The remote terminal makes this data request immediately after the user types the program identification code. This request is not repeated if more than one hourly runway capacity case is analyzed before termination of computer access. If the user enters a Y response, the remote terminal will print a description of future ATC systems.

For additional information on future ATC Systems, contact:

Director, Office of Systems
 Engineering Management
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

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a. All figures used in this chapter (Figures 3-1 through 3-5) are located at the end of this chapter.

ENTER PRESENT OR FUTURE ATC SYSTEM
(P F1 F2 G3 H4).

The remote terminal always makes this data request. If the user entered a Y response to the question above and wishes to use a future system in the technique, he enters one of the system codes supplied by the remote terminal in response to the above question (i.e., F1, F2, G3, or H4). The user enters the letter P for the present ATC system.

ENTER VFR, IFR, OR PVC.

The computerized technique considers three ceiling and visibility conditions (defined in Paragraph 5.a.(1), on page 5): VFR, IFR, and PVC.

The remote terminal always makes this data request; valid user responses are: V for VFR, I for IFR, or P for PVC.

DO GA AIRCRAFT FLY A SHORT FINAL APPROACH?

The remote terminal only makes this data request for VFR conditions. The user enters a Y response if the majority of general aviation aircraft make a curved approach and fly a final approach less than three miles on a straight line extension of the runway centerline. The user enters an N response if the majority of general aviation aircraft fly (1) a final approach of at least three miles on an extension of the runway centerline, or (2) the same final approach pattern as air carrier aircraft.

ENTER RUNWAY USE DIAGRAM NUMBER (1-51)

Figure 3-2 illustrates the 51 runway use diagrams used in the computerized hourly runway capacity technique. The user enters the number of the appropriate runway use diagram.

ENTER AIRCRAFT MIX (PERCENT CLASS A B C D) FOR EACH PRINTED RUNWAY NUMBER

The user enters the aircraft mix as four integers which sum to 100. The first integer is the percent of aircraft in Class A, the second integer is the percent of aircraft in Class B, etc. Aircraft classes are defined in Figure 1-2. The user should

repeat the same aircraft mix for every runway; to save time, the user can enter the letter A after the aircraft mix for the first runway (e.g., 60 30 10 0 A), and the remote terminal will automatically repeat the aircraft mix percentages.

If capacity values corresponding to different mixes on runways are desired, in general, the user should employ the computer simulation model described in Chapter 4.

The most common runway uses involving different aircraft mixes on runways are Runway Use Diagrams Nos. 5, 12, and 22 on Figure 3-2 (i.e., parallel runways with arrivals and departures on all runways). A procedure to determine the capacity of these runway uses with different mixes on each runway is presented in Appendix 5.

Although the computerized hourly runway capacity technique can accept a different aircraft mix for each runway, inputting different mixes for each runway should not be attempted except for certain research applications by individuals who are familiar both with air traffic control procedures and the fine-grain details of the computer programs used to determine hourly runway capacity. The values obtained when different aircraft mixes are used should not be considered as hourly capacities and are not applicable unless modified by complex manual calculations.

ENTER SEPARATION "S" BETWEEN PARALLEL RUNWAYS (FEET)

The remote terminal makes this data request for the runway uses which have the letter S in Figure 3-2 (i.e., Runway Use Diagrams Nos. 2 through 12, 17, 27, and 28). The value of S must exceed 3,500 feet for Runway Use Diagram No. 17. The user must enter the separation S as the distance in feet.

ENTER DISTANCE "X" BETWEEN THRESHOLD AND INTERSECTION FOR EACH PRINTED RUNWAY NUMBER (FEET)

The remote terminal makes this data request for Runway Use Diagrams Nos. 23 through 26 on Figure 3-2. The runway numbers are identified in Figure 3-2. The distance is measured in feet from the threshold (in the direction of operations) to the intersection point. The user must enter the distance X as an integer between 0 and 10000.

ENTER ANGLE "A" BETWEEN NONPARALLEL RUNWAYS (DEGREES)

The remote terminal makes this data request (and the next data request) for Runway Use Diagrams Nos. 31, 33, 35, 39, 42, 44, 46, and 50 on Figure 3-2. The user must enter angle, A, as an integer between 0 and 90, i.e., the angle in degrees.

ENTER DISTANCE "D" BETWEEN THE THRESHOLD AND CENTERLINE OF NONPARALLEL RUNWAY (FEET)

The remote terminal makes this data request for the same runway uses as the previous request. For Runway Use Diagrams Nos. 31 and 42, on Figure 3-2, the distance, D, is the shortest distance between the threshold of Runway 2 and the centerline (or extended centerline) of Runway 1. For Runway Use Diagrams Nos. 44, 46, and 50, the distance, D, is the shortest distance between the threshold of Runway 3 and the centerline (or extended centerline) of Runway 1. The user must enter this distance as an integer, i.e., the distance in feet.

ENTER PERCENT ARRIVALS

Percent arrivals is defined in paragraph 5.a.(4) on page 6. The user enters percent arrivals as an integer from 0 to 100.

ENTER PERCENT TOUCH-AND-GO

The remote terminal only makes this data request in VFR weather for Runway Use Diagrams Nos. 1, 3, 4, and 5. The maximum allowable percent touch-and-go cannot exceed either (1) twice the percent arrivals, or (2) 200% minus twice the percent arrivals. The user must enter an integer no greater than the maximum allowable percent touch-and-go.

ENTER EXIT DISTANCES AND RUNWAY LENGTH (FEET) FOR EACH PRINTED RUNWAY NUMBER. IDENTIFY HIGH SPEED EXITS WITH AN "H" AFTER DISTANCE. ENTER "W" AFTER RUNWAY LENGTH TO IDENTIFY WET RUNWAYS.

The remote terminal makes this data request for each runway in the appropriate runway use diagram as shown on Figure 3-2. Exit distances are measured in feet from the arrival threshold. The user must enter

exit distances as positive integers in ascending order (e.g., 4000 8000 10000). No two exit distances may be the same, and any number greater than 11000 is considered to equal 11,000 feet.

High-speed exits are those exit taxiways with centerlines at an angle of 30° from the runway centerline in the direction of flow. The user should identify high-speed exits by entering the letter H immediately after the exit distance (e.g., 4410H).

Wet runways[a] are identified by entering the letter W one space after the final exit distance of Runway 1 (e.g., 3250 4410A 8430W). Dry runways are assumed if the letter W is not entered.

The hourly runway capacity techinque assumes that an exit exists at the end of the runway. If the remaining exit locations are unknown or not considered important for the particular application of the computerized runway capacity technique, the user enters the letter S (S is equivalent to exits on a dry runway at 2,000, 3,000, 4,000, 5,000, 6,000, 7,000, and 9,000 feet).

After the above entries, the remote terminal prints the various outputs of the hourly capacity calculation, as described in paragraph 32.b below.

DO YOU WISH TO PERFORM ANOTHER CALCULATION?

A response of Y or YES automatically starts the data request sequence for a new configuration with ENTER PRESENT OR FUTURE ATC CONFIGURATION (P F1 F2 G3 H4).

Any other response automatically terminates the computer access and the remote terminal types data on computer time used. The telephone can be disconnected from the remote terminal at this time.

b. <u>Computerized Hourly Runway Capacity Model Outputs.</u> The remote terminal types an input summary immediately after valid data on exit location and runway length are entered for the last runway. The input summary defines the program version number and the inputs

---

a. Runways with sufficient surface moisture to cause degradation in aircraft braking capabilities, not including snow or ice conditions.

used (without any error messages) and can be used as a permanent record of the calculation.

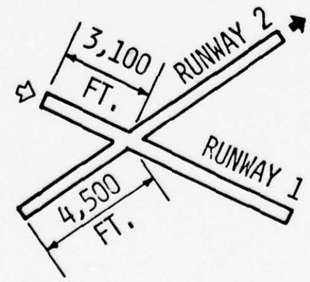
If the user specifies a runway length below that normally required to accommodate the exiting characteristics of the specified aircraft mix, the computerized technique automatically assumes an increased runway length and prints the length used in the calculation as part of the output.

The remote terminal prints two lines of information between the input summary and the output which are not relevant for airport planning applications. The first line is a description of the computer subroutine used for the particular runway use configuration. The second line defines the version number of the batch model used; this number should not be confused with the version number of the computerized technique.

Finally, the remote terminal prints the hourly capacity of runways, the arrival component of capacity, and the departure component of capacity.

Example 1, Hourly Capacity, Intersecting Runways, PVC

Consider an intersecting runway configuration as illustrated below.



Determine the hourly capacity of the intersecting runways in PVC under the following conditions:

ATC System: Present
Aircraft Mix: 0% A, 5% B, 55% C, and 40% D
Percent Arrivals: 55%
Exit Taxiway Location: 3,800 feet, 5,100 feet, 6,500 feet, and 9,000 feet from the arrival threshold.

For the above runway use, from Figure 3-2, Runway Use Diagram No. 23 is selected. For the assumed condition, the sample worksheet is completed (as illustrated in the reproduction of Figure 3-3 below).

DATA REQUEST	APPLICABILITY OF DATA REQUEST	VALID INPUT	CONFIGURATION NO. 1	CONFIGURATION NO. 2	CONFIGURATION NO. 3	CONFIGURATION NO. 4
DO YOU WANT A DESCRIPTION AND IMPLEMENTATION SCHEDULE FOR FUTURE ATC SYSTEMS?	After accessing computer	y or n	n			
ENTER PRESENT OR FUTURE ATC SYSTEM (P F1 F2 G3 H4)	Always used	p, f1, f2, g3, or h4	p			
ENTER VFR, IFR, OR PVC	Always used	v, i, or p	p			
DO GA AIRCRAFT FLY A SHORT FINAL APPROACH?	VFR only	y or n	n			
ENTER RUNWAY USE DIAGRAM NUMBER (1-51)	Always used	Integer 1 thru 51	2,3			
ENTER AIRCRAFT MIX PERCENT CLASS A B C D) FOR EACH PRINTED RUNWAY NUMBER 1- 2- 3- 4-	For all runways in the runway use diagram	Four integers which sum to 100. Use the same mix for all runways.	0,5,55,40			
ENTER SEPARATION "S" BETWEEN PARALLEL RUNWAYS (FEET)	R/W Use Diag. 2-12,17,27,28	Integer	—			
ENTER DISTANCE "X" BETWEEN THRESHOLD AND INTERSECTION FOR EACH PRINTED RUNWAY NUMBE[illegible]EET) 1 2 3 4	R/W Use Diag. 23,24,25,26. For all runways.	Integer under 10000	— 3100 4,500			
ENTER ANGLE "A" BETWEEN NONPARALLEL RUNWAYS (DEGREES)	R/W Use Diag. 31,33,35,39, 42,44,46,50	Integer 1 thru 90	—			
ENTER DISTANCE "D" BETWEEN THE THRESHOLD AND CENTERLINE OF NONPARALLEL RUNWAY (FEET)	R/W Use Diag. 31,33,35,39, 42,44,46,50	Integer	—			
ENTER PERCENT ARRIVALS	Always used	Integer 0 thru 100	55			
ENTER PERCENT TOUCH AND GO	VFR only	Integer less than 2(% Arrivals) and 2(100-% Arrivals)	0			
ENTER EXIT DISTANCES AND RUNWAY LENGTH (FEET) FOR EACH PRINTED RUNWAY NUMBER. IDENTIFY HIGH SPEED EXITS WITH AN "H" AFTER DISTANCE. ENTER "W" AFTER RUNWAY LENGTH TO IDENTIFY WET RUNWAY 1 2 3 4	Based on runway use diag.	Integers in ascending order, separated by a space. An 'h' can be entered after any number of exits. A 'w' after no. I runway length identifies wet runways.	3800 5100 6500 9000			
DO YOU WISH TO PERFORM ANOTHER CALCULATION?	After output	y or n	n			

The computerized technique output, indicating the data input dialogue, the input summary, and the results for the assumed conditions, is shown below. For illustration, all inputs provided by the user are circled.

Two errors were made in the input sequence to illustrate error messages. From the illustration below, hourly capacity of the runways is 56.0 operations per hour.

```
                  *** AIRFIELD HOURLY CAPACITY MODEL ***
                          VERSION 2 (MAY 1976)

DO YOU WANT A LISTING AND IMPLEMENTATION
SCHEDULE OF FUTURE ATC SYSTEMS?
n

ENTER PRESENT OR FUTURE ATC SYSTEM (P F1 F2 G3 H4)
p

ENTER VFR, IFR, OR PVC
p

ENTER RUNWAY USE DIAGRAM NUMBER (1 - 51)
23

ENTER AIRCRAFT MIX    ( PERCENT CLASS A B C D)
FOR EACH PRINTED RUNWAY NUMBER
1-
0 10 55 40

ERR:  MIX PERCENTAGE DOES NOT TOTAL 100 FOR RUNWAY # 1
REENTER
1-
0 5 55 40 A

ENTER DISTANCE "X" BETWEEN THRESHOLD AND
INTERSECTION FOR EACH PRINTED RUNWAY NUMBER (FEET)
1-
3100
2-
4500

ENTER PERCENT ARRIVALS
55

ENTER EXIT DISTANCES AND RUNWAY LENGTH (FEET)
FOR EACH PRINTED RUNWAY NUMBER.  IDENTIFY HIGH SPEED
EXITS WITH H AFTER DISTANCE.  ENTER W AFTER
RUNWAY LENGTH TO IDENTIFY WET RUNWAY.
1-
3800 51000 6500 9000

WARNING:  RUNWAY EXIT DISTANCE OF 51000 SET TO MAXIMUM OF 11000

ERR:  EXIT DISTANCES MUST BE POSITIVE INTEGERS ENTERED IN ASCENDING ORDER

1-
3800 5100 6500 9000

         *** INPUT SUMMARY ***
         VERSION 2 (MAY 1976)

         P ATC CONFIGURATION
         PVC
         DRY RUNWAY
         RUNWAY USE DIAGRAM # 23
         55 PERCENT ARRIVALS
          0 PERCENT TOUCH & GO
         DISTANCES BETWEEN THRESHOLDS AND INTERSECTION     3100     4500
R/W     AIRCRAFT   MIX   TYPE
 #      %A   %B   %C   %D   OPN     EXIT LOCATIONS (FT)

1       0.   5.   55.  40.  ARR     3800   5100   6500   9000
2       0.   5.   55.  40.  DEP

TWO INTERSECTING, ARR ON #1, DEP ON #2

BATCH CAPACITY PROGRAM, VERSION 5


         ***  AIRFIELD HOURLY RUNWAY CAPACITY  ***

         TOTAL =  56.0  ARRIVAL =  30.8  DEPARTURE =  25.2
```

Example 2, Hourly Capacity, Location of Additional Exits, VFR

Determine the increase in the hourly capacity of a single runway in VFR if an additional exit taxiway is provided at 3,500 feet or 4,500 feet for the following conditions:

ATC System: Present
Aircraft Mix: 60% A, 30% B, 10% C, and 0% D
Percent Arrivals: 50%
Percent Touch-and-Go: 0%
Existing Exit Taxiway Location: 2,400 feet and 5,700 feet from the arrival threshold.

This example requires three runs of the computerized technique for hourly runway capacity. The first run considers the two existing exit taxiways. The second run considers exit taxiways at 2,400 feet, 3,500 feet, and 5,700 feet; the third run considers exit taxiways at 2,400 feet, 4,500 feet, and 5,700 feet. The information typed at the remote terminal for the first run is presented on the next page. The inputs for the other two runs are identical except for the additional exit locations.

The results of the three runs for this example are:

Run	Exit Taxiway Location (feet from arrival threshold)	Hourly Capacity (operations per hour)
1	2400 and 5700	77.2
2	2400, 3500, and 5700	81.0
3	2400, 4500, and 5700	80.1

```
DO YOU WISH TO PERFORM ANOTHER CALCULATION?
y

ENTER PRESENT OR FUTURE ATC SYSTEM (P F1 F2 G3 H4)
p

ENTER VFR, IFR, OR PVC
v

DO GA AIRCRAFT FLY A SHORT FINAL APPROACH?
y

ENTER RUNWAY USE DIAGRAM NUMBER (1 - 15)
1

ENTER AIRCRAFT MIX    (PERCENT CLASS A B C D)
FOR EACH PRINTED RUNWAY NUMBER
1-
60  30  10  0

ENTER PERCENT ARRIVALS
50

ENTER PERCENT TOUCH & GO
0

ENTER EXIT DISTANCES AND RUNWAY LENGTH (FEET)
FOR EACH PRINTED RUNWAY NUMBER. IDENTIFY HIGH SPEED
EXITS WITH H AFTER DISTANCE. ENTER W AFTER
RUNWAY LENGTH TO IDENTIFY WET RUNWAY.
1-
2400  5700

          *** INPUT SUMMARY ***
          VERSION 2 (MAY 1976)

          P ATC CONFIGURATION
          VFR WEATHER
          DRY RUNWAY
          RUNWAY USE DIAGRAM # 1
          50 PERCENT ARRIVALS
           0 PERCENT TOUCH & GO
R/W     AIRCRAFT    MIX    TYPE
 #      %A   %B   %C   %D    OPN     EXIT LOCATIONS (FT)

 1      60.  30.  10.  0.    BOTH    2400    5700



SINGLE RUNWAY MIXED OPERATIONS WITHOUT T & G

BATCH CAPACITY PROGRAM, VERSION 4


             ***  AIRFIELD HOURLY RUNWAY CAPACITY ***

             TOTAL = 77.2  ARRIVAL =  38.6  DEPARTURE =  38.6
```

From the above, construction of an additional exit taxiway increases the hourly capacity of the runways by some 3 to 4 operations per hour. Strictly from the standpoint of increasing the hourly capacity of the runway, an additional exit taxiway at 3,500 feet from the runway threshold would be preferred slightly over an additional exit taxiway at 4,500 feet.

33. COMPUTERIZED TECHNIQUE FOR DETERMINING ANNUAL DELAY TO AIRCRAFT ON RUNWAYS. Figure 3-4 summarizes the data requests and valid input format for the computerized annual delay technique.

All entries to the computerized annual runway delay technique are integers; certain combinations of integers are percentages that must sum to 100. The remote terminal types an error message if letters or symbols are entered or if the appropriate percentages do not sum to 100.

Figure 3-5 is a worksheet for the annual delay technique. Because of its volume, input data should be recorded on the worksheet prior to computer access. In addition, the user should check that the appropriate percentages sum to 100.

Annual delay to aircraft on runways is quite sensitive to a number of factors including annual demand, hourly and daily patterns of demand, hourly capacities for various operating conditions (e.g., runway use, ceiling and visibility), and the occurrence of operating conditions. Therefore, it is strongly recommended that actual data for the airport under consideration be used whenever possible. However, optional built-in data concerning certain of these factors are available in the computerized technique for parametric analyses. The optional built-in data are:

- Percent of annual demand in each month
- Frequency of VFR, IFR, and PVC conditions in each month
- Percent of weekly demand in each day
- Percent of daily demand in each hour

A complete description of built-in data is presented in a companion report;[3] in addition, the input summary typed by the remote terminal as part of the output includes a

listing of any built-in data used in a particular application of the computerized technique. Nonetheless, because of the sensitivity noted above, the user should exercise caution when interpreting the results of applications involving built-in data.

a. <u>Data Requests and Acceptable Inputs</u>. The following is a more detailed description of the data requests in Figure 3-4 and the acceptable inputs.

ENTER ANNUAL DEMAND

Annual demand is the number of aircraft operations that desire to use the runway component in the year. Aircraft operations include arrivals, departures, and touch-and-go operations. As described in Paragraph 5.a.(5) on page 6, a touch-and-go is counted as two aircraft operations. As noted in Paragraph 31 on page 142, commas should not be used when entering a number greater than 999 (e.g., enter 225000 instead of 225,000).

ENTER FOR EVERY MONTH

PERCENT OF ANNUAL DEMAND

PERCENT OF MONTH IN VFR, IFR, AND PVC

JANUARY

The user should enter four numbers on the line immediately below the word JANUARY (e.g., 7.6 96 3 1). A space should separate each number. The first number is percent of annual demand in January; the second, third, and fourth numbers are the percents of the time VFR, IFR, and PVC, respectively, occur in January.

The second, third, and fourth numbers must sum to 100; otherwise, the remote terminal repeats the request for JANUARY data.

The remote terminal requests data for FEBRUARY as soon as data in valid format are entered for January. This process is repeated until data are entered for all twelve months. The remote terminal repeats the entire data request if the percents of annual demand for the 12 months do not sum to 100.

The user can determine monthly and annual demand from air traffic activity records or air traffic forecasts. Sources on the monthly occurrence of ceiling and visibility conditions include the appropriate office of the National Weather Service and the Flight Service Station as well as the National Climatic Center in Asheville, North Carolina. Information on the percent of time each condition occurs during peak periods should be used, if available.

As emphasized previously, the user should enter specific airport data if available. However, there are seven optional built-in distributions of the percent of annual operations per month. These built-in distributions are based on historical air traffic activity records and can be employed by entering the appropriate code letter (defining the monthly distribution of operations) as the input for JANUARY.

The code letters and distributions are as follows:

PERCENT OF ANNUAL OPERATIONS PER MONTH

Code Letter	Distribution[a]
A	Uniform (i.e., the same percentage per month)
B	High-activity air carrier airport with a small monthly variation (based on data for Chicago O'Hare International Airport)
C	High-activity air carrier airport with a moderate monthly variation (based on data for San Francisco International Airport)
D	High-activity air carrier airport with a substantial monthly variation (based on data for Boston-Logan International Airport)
E	High-activity general aviation airport with a small monthly variation (based on data for Opa Locka Airport)
F	High-activity general aviation airport with a moderate monthly variation (based on data for Orange County Airport)
G	Moderate-activity general aviation airport with a substantial monthly variation (based on data for Boeing Field/King County International Airport)

a. Reference 3 contains a detailed presentation of all built-in distributions available in the computerized annual delay technique.

In addition, there are four built-in distributions of ceiling and visibility conditions. These built-in distributions can be employed by entering the appropriate code letter as input for January. The code letters and distributions are as follows:

OCCURRENCE OF CEILING AND VISIBILITY CONDITIONS PER MONTH

Code Letter	Distribution[a]
A	99% VFR, 1% IFR, 0% PVC (based on data for Miami International Airport)
B	95% VFR, 4% IFR, 1% PVC (based on data for Tulsa International Airport)
C	88% VFR, 11% IFR, 1% PVC (based on data for Boston-Logan International Airport)
D	80% VFR, 18% IFR, 2% PVC (based on data for Los Angeles International Airport)

a. Reference 3 contains a detailed presentation of all built-in distributions available in the computerized annual delay technique.

ENTER IFR AND PVC OPERATIONS AS A PERCENT OF VFR OPERATIONS

This data request requires two numbers (each between 0 and 100). The first number is the typical ratio of daily demand in IFR conditions to daily demand in VFR conditions times 100.

The second number is the typical ratio of daily demand in PVC conditions to daily demand in VFR conditions times 100.

ENTER DAILY OPERATIONS AS A PERCENT OF WEEKLY OPERATIONS

MONDAY

This data request requires one number (between 0 and 100) be entered. The remote terminal types TUESDAY after the entry for MONDAY; the process is repeated until the user has made an entry for each

day of the week. The remote terminal repeats the entire data request if the seven entries do not sum to 100.

The user can determine data on daily and weekly demand from air traffic activity records or air traffic forecasts. As emphasized previously, specific airport data should be used if available. However, six built-in distributions of the daily percentages of weekly operations are set forth below. These distributions are based on air traffic activity records and can be used by entering the appropriate code letter as the percentage for MONDAY. The particular day of the week which has the highest percent of the week's operations has no impact on annual delay. More important is the magnitude of the seven numbers defining the daily percentages of weekly operations.

PERCENT OF WEEKLY OPERATIONS PER DAY

Code Letter	Distribution[a]
A	Same demand per day
B	Peak day equals 1.15 minimum day (based on data for Chicago O'Hare International Airport)
C	Peak day equals 1.25 minimum day (based on data for Orange County Airport)
D	Peak day equals 1.50 minimum day (based on data for Opa Locka Airport)
E	Peak day equals 1.70 minimum day (based on data for Washington National Airport)
F	Two days each with 25% of the weekly demand; five days each with 10% of the weekly demand

a. Reference 3 contains a detailed presentation of all built-in distributions available in the computerized annual delay technique.

ENTER HOURLY OPERATIONS AS A PERCENT OF DAILY OPERATIONS

0-1

This data request requires one number (between 0 and 100) be entered for each hour of the day. After the user enters data for Hour 0-1, the remote terminal automatically types 1-2. This process is repeated through the Hour 23-24. The remote terminal repeats the entire data request if the 24 numbers do not sum to 100.

The user can determine data on hourly and daily demand from air traffic activity records, field surveys, or air traffic forecasts. As emphasized previously, specific airport data should be used if available. However, there are nine built-in distributions of the hourly distribution of the day's operations, as set forth below. The user can select one of these distributions by entering the appropriate code letter as the percentage during the Hour 0-1.

PERCENT OF DAILY OPERATIONS PER HOUR

Code Letter	Distribution[a]
A	Uniform over 16 hours
B	Based on the three highest-activity air carrier airports (including Chicago O'Hare International Airport and Los Angeles International Airport)
C	Based on the fourth through tenth highest-activity air carrier airports (including John F. Kennedy International Airport and San Francisco International Airport)
D	Based on the eleventh through the twentieth highest-activity air carrier airports (including Philadelphia International Airport and Denver Stapleton International Airport)
E	Based on selected medium hub air carrier airports (such as Jacksonville International Airport and Nashville Metropolitan Airport)
F	Based on selected very high-activity general aviation airports (such as Orange County Airport)
G	Based on selected small hub air carrier airports (such as Fresno Air Terminal and Toledo Express Airport)
H	Based on selected high-activity general aviation airports (such as Long Beach Airport)
I	Based on selected moderate-activity general aviation airports (such as Palo Alto Airport)

a. Reference 3 contains a detailed presentation of all built-in distributions available in the computerized annual delay technique.

ENTER DEMAND PROFILE FACTOR

This data request requires one number (i.e., 25, 30, 35, 40, 45, or 50). The user should derive the demand profile factor in accordance with the procedures in Paragraph 21.f.(3) on page 25.

ENTER THE FOLLOWING FOR EVERY VFR RUNWAY USE: RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX, HOURLY RUNWAY CAPACITY, AND PERCENT OF VFR

This data request requires one or more lines of data, with one line of data for each specific runway use in VFR conditions. The user enters the first number per line as an integer between 1 and 122 corresponding to the runway use diagram number in Figure 2-2. The second number is entered as an integer between 0 and 180 corresponding to the appropriate mix index defined in Paragraph 21.a.(3) on page 23.

The user enters the third number as an integer between 0 and 500 corresponding to the hourly runway capacity of the runways computed using the procedures in Paragraph 22 on page 27, or in Paragraph 32 on page 144. The fourth number line is entered as an integer between 0 and 100 corresponding to the percent of time in VFR conditions that the corresponding runway use occurs. The user can enter any desired number of lines of data; the percent VFR must sum to 100.

The remote terminal proceeds to the next data request when the fourth numbers sum to 100. The remote terminal requests new data if the fourth numbers sum to over 100.

The user should not consider runway uses which are only used during low-activity time periods (e.g., off-peak periods). It is recommended that only runway uses occurring for at least 2% of the time in VFR be considered. Possible sources of runway use information at a particular airport include field observations, FAA air traffic control tower personnel, or airport management.

ENTER THE FOLLOWING FOR EVERY IFR RUNWAY USE: RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX, HOURLY RUNWAY CAPACITY, AND PERCENT OF IFR

This data request concerns runway uses in IFR conditions and parallels the input format of the preceding data request. The remote terminal proceeds to the next data request when the fourth numbers sum to 100.

ENTER THE FOLLOWING FOR EVERY PVC RUNWAY USE: RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX, HOURLY RUNWAY CAPACITY, AND PERCENT OF PVC

This data request concerns runway uses in PVC conditions and parallels the input format of the two preceding data requests. The user should enter data for this data request even if PVC conditions do not occur (e.g., enter 1 1 1 100).

The computer automatically computes annual delay to aircraft on the runways when the fourth numbers sum to 100.

DO YOU WISH TO DETERMINE ANNUAL DELAY FOR ANOTHER ANNUAL DEMAND?

This data request is made after the remote terminal types the output for the previous case. If a Y response is given, the remote terminal will type the following data request.

ENTER ANNUAL DEMAND

The user enters the response as an integer.

The remote terminal then calculates annual delay assuming all other inputs are identical to those used in the previous case. If any response other than Y is given, the remote terminal types the following data request.

DO YOU WISH TO PERFORM ANOTHER CALCULATION?

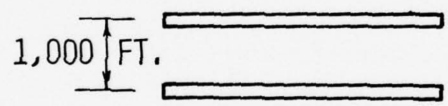
With a Y response to this data request, the remote terminal repeats the entire series of data requests for the annual delay technique. Any other response automatically terminates the connection between the remote terminal and the computer; data on computer time used is typed by the remote terminal. The user can disconnect the telephone at this time.

b. Computerized Annual Delay Input Summary and Output. The input summary is typed immediately after PVC runway use data are input. The input summary lists the data used to determine annual delay; the built-in data will be typed if a code letter was used during the data entry sequence.

The output includes the delay distribution, the total annual delay, and the average delay per operation. The delay distribution lists the percent of the aircraft delayed per time interval. The time intervals are 0.2 minutes each for times under two minutes; thereafter, one minute time intervals are used up to 100 minutes; the last time interval is for all aircraft delayed over 100 minutes. The time interval is not printed if it has zero percent of the aircraft. The total annual runway delay is in hours and the average delay per runway operation is in minutes.

Example 3, Annual Delay, Two Parallel Runways

Determine the annual runway delay at an airport which has the following runway configuration.



This runway configuration is used with arrivals and departures on both runways (runway use diagram number 9 from Figure 2-2) or as a single runway (runway use diagram number 1 from Figure 2-2). The annual demand is 315,000 operations per year.

The information typed at the remote terminal for this example is presented on page 163. The data entered by the user are enclosed for illustration. An input error was made to illustrate the error messages. The actual data typed at the remote terminal contains more blank lines to separate data and contains over 60 lines for the output delay distribution; not all of these lines are included in the example printout for brevity. The total delay is 31,878 hours and the average delay is 6.1 minutes per operation.

```
*** COMPUTERIZED ANNUAL DELAY ***
VERSION 1 (MAY 1976)

ENTER ANNUAL DEMANDS
315000

ENTER FOR EVERY MONTH:
  PERCENT OF ANNUAL DEMANDS
  PERCENT OF MONTH WHICH IS VFR, IFR,
  AND PVC

JANUARY
5.3 84 15 1
FEBRUARY
6.8 97 12 1

ERROR:  INPUT MUST BE FOUR NUMBERS,
THE LAST THREE NUMBERS MUST SUM TO 100

FEBRUARY
6.8 87 12 1
MARCH
8.3 86 13 1
APRIL
9.5 86 13 1
MAY
9.5 87 11 2
JUNE
9.2 89 10 1
JULY
10.6 91 8 1
AUGUST
10 90 9 1
SEPTEMBER
11.5 91 8 1
OCTOBER
7.5 87 12 1
NOVEMBER
6.6 90 9 1
DECEMBER
5.2 89 10 1

ENTER IFR AND PVC OPERATIONS AS A
PERCENT OF VFR OPERATIONS
55 40

ENTER DAILY OPERATIONS AS A
PERCENT OF WEEKLY OPERATIONS

MONDAY
14
TUESDAY
13
WEDNESDAY
12
THURSDAY
12
FRIDAY
15
SATURDAY
18
SUNDAY
16

ENTER HOURLY OPERATIONS AS A
PERCENT OF DAILY OPERATIONS

0-1
0
1-2
0
2-3
0
3-4
0.1
4-5
0.2
5-6
0.5
6-7
1.2
7-8
5.4
8-9
8.2
9-10
9.3
10-11
7.4
11-12
6.2
12-13
7.3
13-14
10.2
14-15
11.5
15-16
10.7
16-17
9.8
17-18
6.3
18-19
3.2
19-20
1.7
20-21
0.7
21-22
0.1
22-23
0
23-24
0

ENTER DEMAND PROFILE FACTOR
25

ENTER THE FOLLOWING FOR EVERY VFR RUNWAY USAGE:
RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX,
HOURLY RUNWAY CAPACITY, AND PERCENT OF VFR DAYS USED
1-
9 30 143 85
2-
1 35 71 15

ENTER THE FOLLOWING FOR EVERY IFR RUNWAY USAGE:
RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX,
HOURLY RUNWAY CAPACITY, AND PERCENT OF IFR DAYS USED
1-
2 70 68 95
2-
1 70 55 5

ENTER THE FOLLOWING FOR EVERY PVC RUNWAY USAGE:
RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX,
HOURLY RUNWAY CAPACITY, AND PERCENT OF PVC DAYS USED
1-
2 80 61 90
2-
1 80 52 10
```

*** INPUT SUMMARY ***
COMPUTERIZED ANNUAL DELAY
VERSION 1 (MAY 1976)

ANNUAL OPERATIONS 315000

MONTH	% OF ANNUAL OPERATIONS	MONTHLY WEATHER % VFR	IFR	PVC
JAN	5.3	84	15	1
FEB	6.8	87	12	1
MAR	8.3	86	13	1
APR	9.5	86	13	1
MAY	9.5	87	11	2
JUN	9.2	89	10	1
JUL	10.6	91	8	1
AUG	10	90	9	1
SEP	11.5	91	8	1
OCT	7.5	87	12	1
NOV	6.6	90	9	1
DEC	5.2	89	10	1

DAILY OPERATIONS (IFR DAY)/(VFR DAY) = 55%
DAILY OPERATIONS (PVC DAY)/(VFR DAY) = 40%

DAILY OPERATIONS AS A PERCENT OF WEEKLY OPNS.

MON	TUES	WED	THU	FRI	SAT	SUN
14	13	12	12	15	18	16

HOURLY OPNS AS A PERCENT OF DAILY OPNS

0-1	0	6-7	1.2	12-13	7.3	18-19	3.2
1-2	0	7-8	5.4	13-14	10.2	19-20	1.7
2-3	0	8-9	8.2	14-15	11.5	20-21	0.7
3-4	0.1	9-10	9.3	15-16	10.7	21-22	0.1
4-5	0.2	10-11	7.4	16-17	9.8	22-23	0
5-6	0.5	11-12	6.2	17-18	6.3	23-24	0

DEMAND PROFILE FACTOR = 25

VFR RUNWAY USAGES

FIG NO.	MIX INDEX	HOURLY CAPACITY	% DAYS USED
9	30	143	85
1	35	71	15

IFR RUNWAY USAGES

2	70	68	95
1	70	55	5

PVC RUNWAY USAGES

2	80	61	90
1	80	52	10

* * * * * * * * * * * * * * *

ANNUAL SUMMARY

AVERAGE DELAY (MINUTES) AT LEAST	LESS THAN	DISTRIBUTION PERCENT OCCURRENCE
0.0	0.2	61.028
0.2	0.4	8.917
0.4	0.6	3.300
0.6	0.8	2.272
.	.	.
.	.	.
.	.	.
90.0	91.0	[illegible]
MORE THAN	100.0	[illegible]

MEAN OF AVERAGE DELAY = 6.07

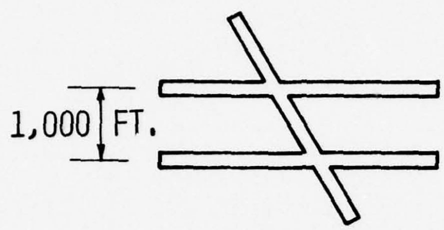
STANDARD DEVIATION = [illegible]

****

ANNUAL DELAY = 31877.823 HOURS
ANNUAL DEMAND = 315000 OPERATIONS
AVERAGE DELAY = 6.07 MINUTES-AIRCRAFT

Example 4, Annual Delay, Two Parallel Plus an Intersecting Runway

Determine the annual runway delay at an airport which has the following runway configuration.



This runway configuration is used as two parallel runways, two intersecting runways, or as a single runway. The annual demand is 425,000 operations per year.

This example makes extensive use of the built-in data. It is recommended that airport specific data be used whenever possible; the built-in data are provided for parametric analyses and where airport specific data are not readily available.

The information typed at the remote terminal for this example is presented on page 165. The data entered by the user are enclosed for illustration. As in Example 3, not all of the output delay distribution data are printed for brevity. The total delay is 28,004 hours and the average delay is 4.0 minutes.

ENTER ANNUAL DEMAND
425000

ENTER FOR EVERY MONTH:
PERCENT OF ANNUAL DEMAND
PERCENT OF MONTH WHICH IS VFR, IFR,
AND PVC

JANUARY
cb

ENTER IFR AND PVC OPERATIONS AS A
PERCENT OF VFR OPERATIONS
75 70

ENTER DAILY OPERATIONS AS A PERCENT
OF WEEKLY OPERATIONS

MONDAY
c

ENTER HOURLY OPERATIONS AS A PERCENT
OF DAILY OPERATIONS

0-1
e

ENTER DEMAND PROFILE FACTOR
30

ENTER THE FOLLOWING FOR EVERY VFR RUNWAY USAGE:
RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX,
HOURLY RUNWAY CAPACITY, AND PERCENT OF VFR DAYS USED

1-
9 60 120 70
2-
43 60 91 25
3-
1 60 64 5

ENTER THE FOLLOWING FOR EVERY IFR RUNWAY USAGE:
RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX,
HOURLY RUNWAY CAPACITY, AND PERCENT OF IFR DAYS USED

1-
2 95 66 85
2-
43 95 66 13
3-
1 95 54 2

ENTER THE FOLLOWING FOR EVERY PVC RUNWAY USAGE:
RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX,
HOURLY RUNWAY CAPACITY, AND PERCENT OF IFR DAYS USED

1-
2 105 57 92
2-
1 110 51 8

*** INPUT SUMMARY ***
COMPUTERIZED ANNUAL DELAY
VERSION 1 (MAY 1976)

ANNUAL OPERATIONS 425000

MONTH	% OF ANNUAL OPERATIONS	MONTHLY WEATHER % VFR	IFR	PVC
JAN	7.8	88	10	2
FEB	7.1	89	9	2
MAR	8.1	91	7	2
APR	8.1	96	4	0
MAY	8.4	96	4	0
JUN	8.7	98	2	0
JUL	9.0	98	2	0
AUG	9.0	99	1	0
SEP	8.7	97	3	0
OCT	8.7	94	5	1
NOV	8.4	95	4	1
DEC	8.0	90	8	2

DAILY OPERATIONS (IFR DAY)/(VFR DAY) = 75%
DAILY OPERATIONS (PVC DAY)/(VFR DAY) = 70%

DAILY OPERATIONS AS A PERCENT OF WEEKLY OPNS

MON	TUES	WED	THU	FRI	SAT	SUN
15	13	13	14	16	14	15

HOURLY OPNS AS A PERCENT OF DAILY OPNS

0-1	1.8	6-7	0.8	12-13	5.2	18-19	8.1
1-2	1.0	7-8	3.1	13-14	5.6	19-20	8.4
2-3	0.6	8-9	7.3	14-15	4.5	20-21	6.1
3-4	0.5	9-10	6.5	15-16	4.9	21-22	5.5
4-5	0.1	10-11	4.1	16-17	6.8	22-23	2.9
5-6	0.3	11-12	5.9	17-18	9.7	23-24	2.1

DEMAND PROFILE FACTOR = 30

VFR RUNWAY USAGES

FIG. NO.	MIX INDEX	HOURLY CAPACITY	% DAYS USED
9	60	120	70
43	60	91	25
1	60	64	5

IFR RUNWAY USAGES

FIG. NO.	MIX INDEX	HOURLY CAPACITY	% DAYS USED
2	95	66	85
43	95	66	13
1	95	54	2

PVC RUNWAY USAGES

FIG. NO.	MIX INDEX	HOURLY CAPACITY	% DAYS USED
2	105	57	92
1	110	51	8

* *

ANNUAL SUMMARY

AVERAGE DELAY (MINUTES) AT LEAST	LESS THAN	DISTRIBUTION PERCENT OCCURRENCE
0.0	0.2	25.554
0.2	0.4	21.128
0.4	0.6	7.360
0.6	0.8	8.829
0.8	1.0	3.278
1.0	1.2	2.556
.	.	.
.	.	.
.	.	.
.	.	.
80.0	81.0	0.317

MEAN OF AVERAGE DELAY = 3.95
STANDARD DEVIATION = 4.33

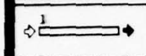
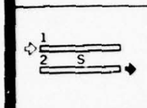
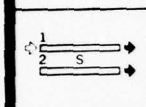
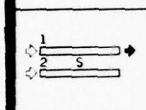
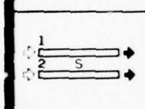
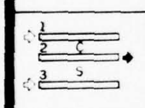
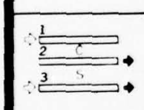
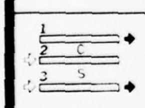
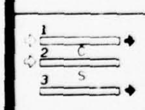
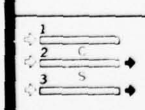
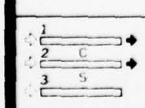
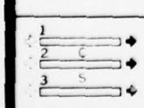
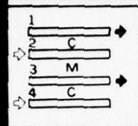
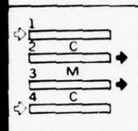
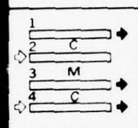
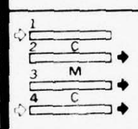
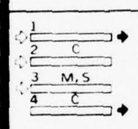
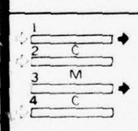
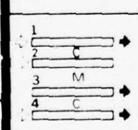
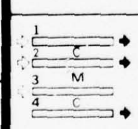
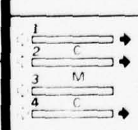
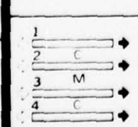
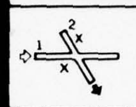
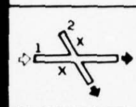
****

ANNUAL DELAY = 28004.058 HOURS
ANNUAL DEMAND = 425000 OPERATIONS
AVERAGE DELAY = 3.95 MINUTES-AIRCRAFT

34.-39. Reserved.

DATA REQUEST	APPLICABILITY OF DATA REQUEST	VALID INPUT	MESSAGE FOR INVALID DATA
DO YOU WANT A DESCRIPTION AND IMPLEMENTATION SCHEDULE FOR FUTURE ATC SYSTEMS?	After accessing computer	y or n	Any response other than "n" is treated as a yes reply.
ENTER PRESENT OR FUTURE ATC SYSTEM (P F1 F2 G3 H4)	Always used	p,f1,f2 g3, or h4	ERR: INCORRECT ATC SYSTEM
ENTER VFR, IFR, OR PVC	Always used	v, i, or p	ERR: MUST BE VFR, IFR, OR PVC
DO GA AIRCRAFT FLY A SHORT FINAL APPROACH?	VFR only	y or n	ERR: ANSWER MUST BE YES OR NO
ENTER RUNWAY USE DIAGRAM NUMBER (1-51)	Always used	Integer 1 thru 51	ERR: RUNWAY USE DIAGRAM NUMBER MUST BE BETWEEN 1 & 51
ENTER AIRCRAFT MIX PERCENT CLASS A B C D) FOR EACH PRINTED RUNWAY NUMBER 1- 2- 3- 4-	For all runways in the runway use diagram	Four integers which sum to 100. Use the same mix for all runways.	ERR: MIX PERCENTAGES DO NOT TOTAL 100 FOR RUNWAY ___ REENTER
ENTER SEPARATION "S" BETWEEN PARALLEL RUNWAYS (FEET)	R/W Use Diag. 2-12,17,27,28	Integer	The data request is repeated if the entry isn't an integer.
ENTER DISTANCE "X" BETWEEN THRESHOLD AND INTERSECTION FOR EACH PRINTED RUNWAY NUMBER (FEET) 1 2 3 4	R/W Use Diag. 23,24,25,26. For all runways.	Integer under 10000	ERR: THRESHOLD TO INTERSECTION DISTANCE MUST BE AN INTEGER BETWEEN 0 & 9999
ENTER ANGLE "A" BETWEEN NONPARALLEL RUNWAYS (DEGREES)	R/W Use Diag. 31,33,35,39, 42,44,46,50	Integer 1 thru 90	ERR: ANGLE MUST BE AN INTEGER BETWEEN 1 & 90
ENTER DISTANCE "D" BETWEEN THE THRESHOLD AND CENTERLINE OF NONPARALLEL RUNWAY (FEET)	R/W Use Diag. 31,33,35,39, 42,44,46,50	Integer	The data request is repeated if the entry isn't an integer.
ENTER PERCENT ARRIVALS	Always used	Integer 0 thru 100	ERR: PERCENTAGE MUST BE AN INTEGER BETWEEN 0 & 100
ENTER PERCENT TOUCH AND GO	VFR only	Integer less than 2(% Arrivals) and 2(100-% Arrivals)	ERR: PERCENTAGE MUST BE AN INTEGER BETWEEN 0 & ___
ENTER EXIT DISTANCES AND RUNWAY LENGTH (FEET) FOR EACH PRINTED RUNWAY NUMBER. IDENTIFY HIGH SPEED EXITS WITH AN "H" AFTER DISTANCE. ENTER "W" AFTER RUNWAY LENGTH TO IDENTIFY WET RUNWAY 1 2 3 4	Based on runway use diag.	Integers in ascending order, separated by a space. An 'h' can be entered after any number of exits. A 'w' after no. 1 runway length identifies wet runways.	ERR: EXIT DISTANCES MUST BE POSITIVE INTEGERS ENTERED IN ASCENDING ORDER. ERR: EXIT ___ IS TREATED THE SAME AS THE PREVIOUS EXIT, NO TWO EXITS MAY BE THE SAME. REENTER.
DO YOU WISH TO PERFORM ANOTHER CALCULATION?	After output	y or n	Program automatically terminates for any entry except "y."

FIGURE 3–1 SUMMARY OF DATA INPUT FOR COMPUTERIZED HOURLY RUNWAY CAPACITY TECHNIQUE

RUNWAY USE DIAGRAM	DIAG. NO.	ADDITIONAL DATA
	1	
	2	S
	3	S
	4	S
	5	S
	6	S
	7	S
	8	S
	9	S
	10	S
	11	S
	12	S
	13	
	14	
	15	
	16	
	17	S
	18	
	19	
	20	
	21	
	22	
	23	X,X
	24	X,X
	25	X,X,X,X
	26	X,X,X,X

LEGEND:

⇨ Indicates that an arrival (or landing) may occur on the runway indicated.

➡ Indicates that a departure (or takeoff) may occur on the runway indicated.

The lack of a symbol means that aircraft operations will not or cannot occur from the runway indicated.

S Indicates a variable runway spacing (feet).

C Indicates runway spacing category 700-2499 feet.

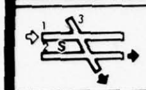
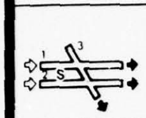
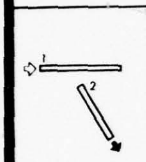
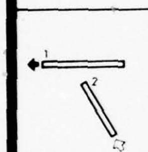
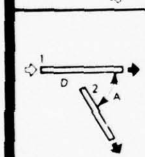
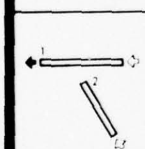
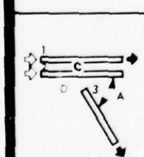
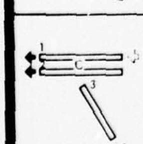
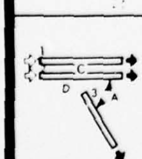
X Indicates distance from threshold to intersection (feet).

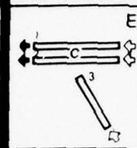
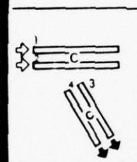
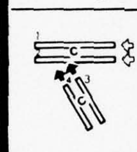
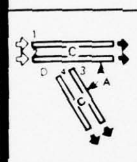
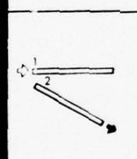
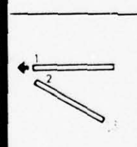
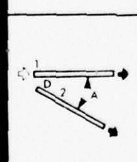
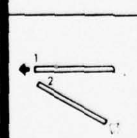
A Indicates the angle between nonparallel runways (degrees).

D Indicates distance from centerline of runway 1 to threshold of far non-parallel runway (feet).

M Indicates runway spacing over 3500 feet.

FIGURE 3–2 RUNWAY USES FOR COMPUTERIZED TECHNIQUE

RUNWAY USE DIAGRAM	DIAG. NO.	ADDITIONAL DATA
	27	S
	28	S
	29	
	30	
	31	D,A
	32	
	33	D,A
	34	
	35	D,A

RUNWAY USE DIAGRAM	DIAG. NO.	ADDITIONAL DATA
	36	
	37	
	38	
	39	D,A
	40	
	41	
	42	D,A
	43	

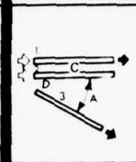
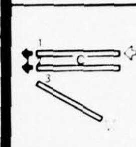
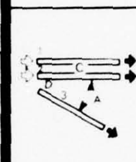
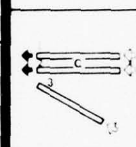
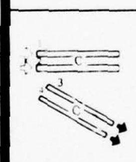
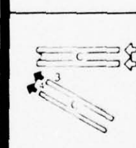
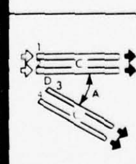
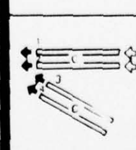
RUNWAY USE DIAGRAM	DIAG. NO.	ADDITIONAL DATA
	44	D,A
	45	
	46	D,A
	47	
	48	
	49	
	50	D,A
	51	

FIGURE 3–2 RUNWAY USES FOR COMPUTERIZED TECHNIQUE (CONTINUED)

DATA REQUEST	APPLICABILITY OF DATA REQUEST	VALID INPUT	CONFIGURATION NO. 1	CONFIGURATION NO. 2	CONFIGURATION NO. 3	CONFIGURATION NO. 4
DO YOU WANT A DESCRIPTION AND IMPLEMENTATION SCHEDULE FOR FUTURE ATC SYSTEMS?	After accessing computer	y or n				
ENTER PRESENT OR FUTURE ATC SYSTEM (P F1 F2 G3 H4)	Always used	p,f1,f2 g3, or h4				
ENTER VFR, IFR, OR PVC	Always used	v, i, or p				
DO GA AIRCRAFT FLY A SHORT FINAL APPROACH?	VFR only	y or n				
ENTER RUNWAY USE DIAGRAM NUMBER (1 - 51)	Always used	Integer 1 thru 51				
ENTER AIRCRAFT MIX PERCENTAGE (CLASS A B C D) FOR EACH PRINTED RUNWAY NUMBER 1- 2- 3- 4-	For all runways in the runway use diagram	Four integers which sum to 100. Use the same mix for all runways.				
ENTER SEPARATION "S" BETWEEN PARALLEL RUNWAYS (FEET)	R/W Use Diag. 2-12,17,27,28	Integer				
ENTER DISTANCE "X" BETWEEN THRESHOLD AND INTERSECTION FOR EACH PRINTED RUNWAY NUMBER (FEET) 1 2 3 4	R/W Use Diag. 23,24,25,26. For all runways.	Integer under 10000				
ENTER ANGLE "A" BETWEEN NONPARALLEL RUNWAYS (DEGREES)	R/W Use Diag. 31,33,35,39, 42,44,46,50	Integer 1 thru 90				
ENTER DISTANCE "D" BETWEEN THE THRESHOLD AND CENTERLINE OF NONPARALLEL RUNWAY (FEET)	R/W Use Diag. 31,33,35,39, 42,44,46,50	Integer				
ENTER PERCENT ARRIVALS	Always use	Integer 0 thru 100				
ENTER PERCENT TOUCH AND GO	VFR only 1	Integer less than 2(% Arrivals) and 2(100-% Arrivals)				
ENTER EXIT DISTANCES AND RUNWAY LENGTH (FEET) FOR EACH PRINTED RUNWAY NUMBER. IDENTIFY HIGH SPEED EXITS WITH AN "H" AFTER DISTANCE. ENTER "W" AFTER RUNWAY LENGTH TO IDENTIFY WET RUNWAY 1 2 3 4	Based on runway use diag.	Integers in ascending order, separated by a space. An 'h' can be entered after any number of exits. A 'w' after no. 1 runway length identifies wet runways.				
DO YOU WISH TO PERFORM ANOTHER CALCULATION?	After	y or n				

FIGURE 3–3 COMPUTERIZED HOURLY RUNWAY CAPACITY TECHNIQUE WORK SHEET

DATA REQUEST	VALID INPUT DATA
ENTER ANNUAL DEMAND	An integer
ENTER FOR EACH MONTH: PERCENT OF ANNUAL DEMAND PERCENT OF MONTH WHICH IS VFR, IFR, AND PVC JANUARY *thru* DECEMBER	Four number per month. The second, third and fourth numbers must sum to 100 for every month. The 12 first numbers must sum to 100.
ENTER IFR AND PVC OPERATIONS AS A PERCENT OF VFR OPERATIONS	Two integers, both between 0 and 100.
ENTER DAILY OPERATIONS AS A PERCENT OF WEEKLY OPERATIONS MONDAY thru SUNDAY	One number per day. The 7 numbers must sum to 100.
ENTER HOURLY OPERATIONS AS A PERCENT OF DAILY OPERATIONS 0 - 1 1 - 2 *thru* 23 - 24	One number per hour. The 24 numbers must sum to 100.
ENTER DEMAND PROFILE FACTOR	The integer 25, 30, 35, 40, 45, or 50.
ENTER THE FOLLOWING FOR EVERY VFR RUNWAY USAGE: RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX, HOURLY RUNWAY CAPACITY, AND PERCENT OF VFR DAYS USED. ENTER THE FOLLOWING FOR EVERY IFR RUNWAY USAGE: RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX, HOURLY RUNWAY CAPACITY, AND PERCENT OF IFR DAYS USED. ENTER THE FOLLOWING FOR EVERY PVC RUNWAY USAGE: RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX, HOURLY RUNWAY CAPACITY, AND PERCENT OF PVC DAYS USED.	The VFR, IFR, and PVC versions of this data request use an identical input format. A maximum of six lines of data can be input, one line per runway usage. Each line contains four numbers; the following defines the range of each number: 1st number - integer, 1 through 122 2nd number - integer, 0 through 180 3rd number - integer, 1 through 500 4th number - number, 1 through 100 The fourth numbers must sum to 100 for each of VFR, IFR, and PVC.
DO YOU WISH TO DETERMINE ANNUAL DELAY FOR ANOTHER ANNUAL DEMAND?	y for yes or n for no.
DO YOU WISH TO PERFORM ANOTHER CALCULATION?	Program automatically terminates for any input other than y.

FIGURE 3-4 SUMMARY OF DATA INPUT FOR COMPUTERIZED ANNUAL DELAY TECHNIQUE

DATA REQUEST	VALID INPUT DATA	CONFIGURATION NO. 1	CONFIGURATION NO. 2	CONFIGURATION NO. 3	CONFIGURATION NO. 4
ENTER ANNUAL DEMAND	*An integer*				
ENTER FOR EACH MONTH: PERCENT OF ANNUAL DEMAND PERCENT OF MONTH WHICH IS VFR, IFR, AND PVC JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER	Four number per month. The second, third and fourth numbers must sum to 100 for every month. The 12 first numbers must sum to 100.				
ENTER IFR AND PVC OPERATIONS AS A PERCENT OF VFR OPERATIONS	Two integers, both between 0 and 100.				
ENTER DAILY OPERATIONS AS A PERCENT OF WEEKLY OPERATIONS MONDAY TUESDAY WEDNESDAY THURSDAY FRIDAY SATURDAY SUNDAY	One number per day. The 7 numbers must sum to 100.				
ENTER HOURLY OPERATIONS AS A PERCENT OF DAILY OPERATIONS 0 - 1 1 - 2 2 - 3 3 - 4 4 - 5 5 - 6 6 - 7 7 - 8 8 - 9 9 - 10 10 - 11 11 - 12 12 - 13 13 - 14 14 - 15 15 - 16 16 - 17 17 - 18 18 - 19 19 - 20 20 - 21 21 - 22 22 - 23 23 - 24	One number per hour. The 24 numbers must sum to 100.				
ENTER DEMAND PROFILE FACTOR	The integer 25, 30, 35, 40, 45, or 50.				
ENTER THE FOLLOWING FOR EVERY VFR RUNWAY USAGE: RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX, HOURLY RUNWAY CAPACITY, AND PERCENT OF VFR DAYS USED.	The VFR, IFR, and PVC versions of this data request use an identical input format.				
ENTER THE FOLLOWING FOR EVERY IFR RUNWAY USAGE: RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX, HOURLY RUNWAY CAPACITY, AND PERCENT OF IFR DAYS USED.	A maximum of six lines of data can be input, one line per runway usage. Each line contains four numbers; the following defines the range of each number: 1st number - integer, 1 through 122 2nd number - integer, 0 through 180 3rd number - integer, 1 through 500 4th number - number, 1 through 100				
ENTER THE FOLLOWING FOR EVERY PVC RUNWAY USAGE: RUNWAY USE DIAGRAM NUMBER FROM FIGURE 2-2, MIX INDEX, HOURLY RUNWAY CAPACITY, AND PERCENT OF PVC DAYS USED.	The fourth numbers must sum to 100 for each of VFR, IFR, and PVC.				
DO YOU WISH TO DETERMINE ANNUAL DELAY FOR ANOTHER ANNUAL DEMAND?	y for yes or n for no.				
DO YOU WISH TO PERFORM ANOTHER CALCULATION?	Program automatically terminates for any input other than y.				

FIGURE 3–5 COMPUTERIZED ANNUAL DELAY TECHNIQUE WORKSHEET

CHAPTER 4. AIRFIELD EVALUATION BY COMPUTER MODELS

40. COMPUTER MODELS FOR CAPACITY AND DELAY. The computer models used to calculate capacity and delay in Chapters 2 and 3 are available for users wishing more detailed information on airfield capacity and delay. This chapter briefly describes the models, the required inputs, and the principal outputs, and also contains information on the availability of the programs and instructions for their use.

41. BRIEF DESCRIPTION OF COMPUTER SIMULATION MODEL. The model simulates the movement of aircraft from the entry gate of the common approach path to the gates, and from the gates to takeoff. The model is a critical events model that employs Monte Carlo sampling techniques. Variable time increments are used as the time flow mechanism (i.e., clock time is advanced by the amount necessary to cause the next most imminent event to take place). Running time for the model is therefore dependent on the aircraft demand levels and the size of the airfield network for any particular application.

Because of the modular structure of the model, the total airfield or its individual components can be analyzed by manipulation of the model inputs. This approach is more flexible and efficient than having separate submodels for the individual components and a composite model for the total airfield.

a. Principal Input Needed for Computer Simulation Model. Because the model is applicable to any airfield layout, it is necessary to input a description of the airfield under consideration as a network of paths that aircraft will follow. This network is defined by dividing the airfield into a series of nodes and links. Other principal inputs to the model include:

Aircraft routings
Runway use
Exit taxiway usage
Runway occupancy times
Aircraft approach velocities
Aircraft taxiing velocities
Aircraft gate service times
Air traffic control rules and procedures
Separations between aircraft
Aircraft demand levels and characteristics

b. Principal Outputs Obtained from Computer Simulation Model. The principal outputs of the model are:

- Total travel times on the airfield for arriving and departing aircraft
- Individual aircraft delay; magnitude and location (i.e., by link)
- Aircraft delay on components of the airfield
- Total delay experienced in various locations on the airfield
- Queue lengths for aircraft waiting to take off
- Actual aircraft operations rates (as opposed to desired or scheduled operations rates)

42. BRIEF DESCRIPTION OF COMPUTER ANALYTICAL MODELS. Three types of analytical models were developed to determine the hourly capacity of individual airfield components--models for capacity of runways, taxiways crossing an active runway, and gates.

Runway capacity models were developed for a large number of runway configurations. For determining the hourly capacity of a taxiway crossing an active runway, one model was developed. Two models were developed for estimating gate capacity. The first model assumes that aircraft can use all gates available; the second model assumes that some aircraft cannot use all the available gates.

These models calculate capacity as the inverse of a weighted average service time of all aircraft being served. For example, if it takes an average of 45 seconds for aircraft to be "served" on a runway, then the capacity of the runway equals one aircraft operation per 45 seconds, or 80 operations per hour.

a. <u>Runway Capacity Models</u>. Information needed to compute the hourly capacity of runways includes the following:

Runway use
Separations between aircraft
Ceiling and visibility
Aircraft mix
Percent arrivals
Percent touch-and-go operations
Aircraft operating characteristics

b. <u>Taxiway Crossing Capacity Model</u>. The following input data are required to compute the hourly capacity of a taxiway crossing an active runway:

Taxiway-runway intersection location
Runway operations rate
Percent arrivals on runway
Headway between taxiing aircraft
Runway clearance distance
Taxiing velocity

c. <u>Gate Capacity Models</u>. The major inputs for purposes of computing the hourly capacity of gates are:

Number and type of gates
Gate mix
Gate occupancy time

43. <u>BRIEF DESCRIPTION OF ANNUAL DELAY MODEL</u>. The annual delay model aggregates hourly delays to aircraft on a daily basis and then aggregates daily delays to provide an estimate of annual delay. Principal inputs to the model include:

- Annual demand
- Weekly demand as a percentage of annual demand

- Daily demand as a percentage of weekly demand
- Hourly demand as a percentage of daily demand
- Demand profile factor
- Weather occurrence
- Runway use occurrence
- Capacities for each runway use and weather combination

The outputs from the model are the average annual delay and total annual delays to aircraft for the annual demand stipulated.

44. AVAILABILITY OF MODEL PROGRAMS AND APPROPRIATE INSTRUCTIONS FOR USE. A detailed description of the models is contained in Report No. FAA-RD-76-128, "Model Users Manual for Airfield Capacity and Delay Models," November 1976. Validation of the capacity and delay models at three high-activity airports is described in a companion report.[2]

The programs are written in a subset of Fortran IV, and consequently, the models can be run on a number of the computers available commercially. For information concerning the availability of the model user manual or magnetic tapes of these programs contact:

Chief, Airport Design Branch (ARD-410)
Federal Aviation Administration
2100 Second Street, S.W.
Washington, D.C. 20590

45.-49. RESERVED.

APPENDIX 1. PRELIMINARY ANALYSIS OF CAPACITY AND DELAY

1. GENERAL. This appendix describes a simplified procedure for obtaining an approximate estimate of hourly capacity, annual service volume, and annual delay to aircraft for various runway configurations. As stated in Chapter 1, this appendix should be used only when a very approximate estimate of capacity or delay is needed. Otherwise, Chapters 2 or 3 should be used in lieu of this appendix. The following information can be obtained using this simplified procedure:

   Hourly capacity of runways in VFR and IFR conditions

   Annual service volume of runways

   Annual delay to aircraft on runways

   Hourly capacities and annual service volumes for a number of runway configurations are presented in Figure A1-1.[a] An approximate estimate of average aircraft delay per year for any runway configuration can be obtained from Figure A1-2. The figures are based on a number of assumptions which are described below. It is emphasized that if conditions at an airport differ significantly from these assumptions, the procedures in Chapters 2 or 3 should be used.

2. ASSUMPTIONS. The assumptions made in the preparation of Figures A1-1 and A1-2 are as follows:

   a. Aircraft Mix. As defined in Chapter 1, aircraft mix is expressed in terms of four aircraft classes, i.e., A, B, C, and D. Sources of aircraft mix information for a particular airport include air traffic forecasts, field surveys, and air traffic activity records.

      For purposes of determining runway capacity using Figure A1-1, information on aircraft mix must be converted to a mix index according to the following formula:

---

a. Figures A1-1 and A1-2 are located at the end of this appendix.

Mix Index = [Percent of Aircraft in Class C]
+ 3 x [Percent of Aircraft in Class D]

or,

Mix Index = Percent (C+3D)

Five ranges of aircraft mix index were established for use of Figure A1-1, as follows:

Mix Index-- Percent (C+3D)
0[a] to 20%
21 to 50
51 to 80
81 to 120
121 to 180

b. Runway Utilization. The hourly capacities shown in Figure A1-1 correspond to the runway utilization which produces the largest capacity consistent with current air traffic control procedures and practices.

It is also assumed that one-half (50%) of the demand for the use of the runways is by arriving aircraft. Thus, the number of arriving and departing aircraft in a specified period of time is equal.

c. Touch-and-Go Operations. The following percentages of touch-and-go operations are assumed in Figure A1-1:

Mix Index-- Percent (C+3D)	Percent Touch-and-Go
0 to 20%	0 to 50%
21 to 50	0 to 40
51 to 80	0 to 20
81 to 120	0
121 to 180	0

---

a. All aircraft are of Classes A and/or B.

d. Taxiways. It is assumed that sufficient taxiways exist to permit capacity of the runways to be fully realized.

e. Taxiway Crossing an Active Runway. The impact on capacity of a taxiway crossing an active runway is assumed to be negligible.

f. Airspace and Aids to Navigation. It is assumed that there is sufficient airspace to accommodate all aircraft wishing to use the runways. In addition, it is assumed that aircraft operations are conducted in a radar environment and at least one runway is equipped with an ILS.

g. Annual Service Volume. The annual service volumes shown on Figure A1-1 are based on the following assumptions:

(1) IFR conditions occur 10% annually.

(2) For Runway Configuration Diagrams Nos. 2 through 27 the utilization of the runways which produces the largest hourly capacity is assumed to occur 80% of the year. An alternative utilization of the runway which produces a smaller capacity is assumed to occur 20% of the year.

A complete listing of runway utilization assumptions is set forth in a companion report.[2]

(3) As described in Chapter 2, annual service volume is dependent on the ratio of annual aircraft operations to daily aircraft operations during the peak month (D) and on the ratio of average daily aircraft operations to average peak hour aircraft operations during the peak month (H).

The following values of D and H were assumed for the mix indices shown in Figure A1-1:

Percent (C+3D)	D	H
0 to 20	290	9
21 to 50	300	10
51 to 80	310	11
81 to 120	320	12
121 to 180	350	14

h. Annual Delay. Annual delay to aircraft on runways is quite sensitive to a number of factors including annual demand, hourly and daily demand patterns, hourly capacities for various operating conditions (e.g., runway use, ceiling and visibility), and the occurrence of operating conditions.

The order of magnitude relationship between average annual delay per aircraft and annual service volume depicted in Figure A1-2 was derived from historical traffic records for a number of high-activity airports and a range of assumptions on likely operating conditions. Typically, the upper portion of the shaded band on Figure A1-2 is representative of airports primarily serving air carrier operations (i.e., above the dotted curve); airports serving primarily general aviation operations may typically fall anywhere within the entire shaded band. The dotted curve on Figure A1-2 is the average of the upper and lower limits of the band indicated.

In the event a more precise estimate of annual delay to aircraft is needed, use of the procedures in Chapter 2 or 3 is strongly recommended.

3. PROCEDURES FOR ESTIMATING RUNWAY CAPACITY. The following procedures should be used in determining the hourly capacity and annual service volume of a runway configuration from Figure A1-1.

a. Determine the mix index.

b. Identify the runway configuration from Figure A1-1.

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TECHNIQUES FOR DETERMINING AIRPORT AIRSIDE CAPACITY AND DELAY.(U)

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c. Select the appropriate range of mix index from Figure A1-1.

d. Obtain the hourly capacity of runway(s) for both VFR and IFR conditions from Figure A1-1.

e. Obtain the annual service volume from Figure A1-1.

<u>Example 1, Hourly Capacity and Annual Service Volume, Single Runway</u>

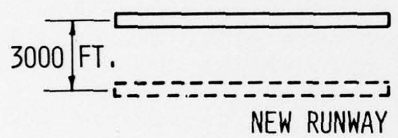
Determine the hourly capacity in VFR and IFR and the annual service volume of a single runway airport with the following aircraft mix: 10% Class A, 25% Class B, 55% Class C, and 10% Class D.

The mix index for the assumed aircraft mix is Percent (C+3D) = 55 + 3 x 10 = 85. From Figure A1-1, the single runway is identified as Runway Configuration No. 1; the appropriate range of mix index is 81 to 120. The hourly runway capacity is 55 operations per hour in VFR and 53 operations per hour in IFR; the annual service volume is 210,000 operations per year (as illustrated in the reproduction of Figure A1-1 below).

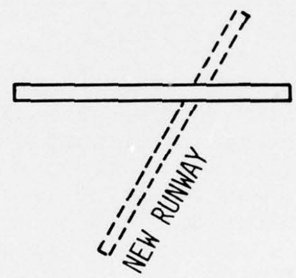
No.	Runway Configuration Diagram	Mix Index--Percent(C+3D)	Hourly Capacity (operations per h ur) VFR	IFR	Annual Service Volume (operati ns per year)
1.		0 to 20	98	59	230,000
		21 to 50	74	57	195,000
		51 to 80	63	56	205,000
		81 to 120	55	53	210,000
		121 to 180	51	50	240,000
2.		0 to 20	197	59	355,000
		21 to 50	145	57	275,000
		51 to 80	121	56	260,000
		[illegible] to 120	105	59	285,000
			[illegible]	60	340,000

Example 2, Hourly Capacity and Annual Service Volume, Additional Runway

Assume that another runway is added to the airport in Example 1; the additional runway can be either parallel or intersecting, as illustrated below. Determine the hourly capacity in VFR and IFR and the annual service volume for each layout.



LAYOUT A



LAYOUT B

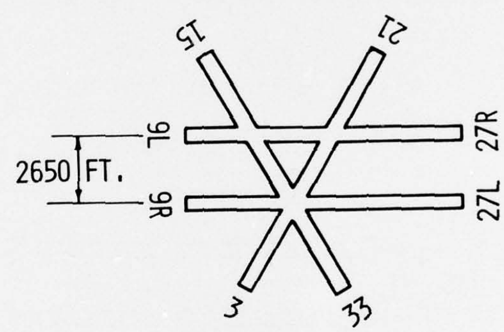
As in Example 1, the appropriate range of mix index is 81 to 120. From Figure A1-1, Layout A is identified as Runway Configuration No. 3; and Layout B is identified as Runway Configuration No. 10. From Figure A1-1, the hourly capacities and annual service volumes of the two runway configurations are as follows:

	Hourly Capacity (operations per hour)		Annual Service Volume (operations per year)
	VFR	IFR	
Configuration 3	111	70	300,000
Configuration 10	76	59	225,000

This example shows that Layout A provides a substantially greater capacity than Layout B.

Example 3, Hourly Capacity and Annual Service Volume, Configuration with Three Runway Orientations

Determine the hourly capacities in VFR and IFR and the annual service volume of the runways at an airport with the runway configuration illustrated below, with the same aircraft mix as in Example 1: 10% Class A, 25% Class B, 55% Class C, and 10% Class D.



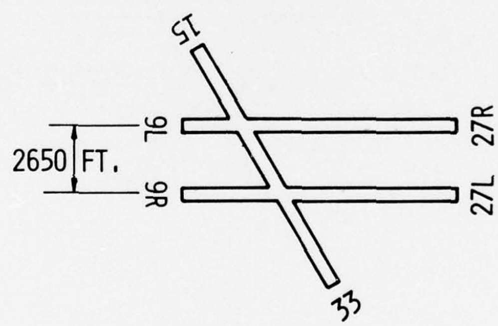
Over the period of a year, the runways are used as follows:

Runway	Percent of Annual Operations
3-21	5%
9-27	70
15-33	25

The configurations shown in Figure A1-1 do not include layouts with more than two runway orientations. Therefore, for those airports with runway configurations involving three or more orientations, it is necessary to identify the runways in the <u>two</u> orientations used most frequently. Possible sources of information on the usage of runways at a particular airport include field observations, FAA air traffic control tower personnel, or airport management.

For purposes of a simplified analysis of capacity, the contribution to capacity of the additional runways in the remaining orientations is minimal and can be ignored.

In this example, the orientations most frequently used are 9-27 and 15-33; therefore, the "effective" two-orientation configuration is as follows:



As in Example 1, the appropriate range of mix index is 81% to 120%. From Figure A1-1, Runway Configuration No. 12 is identified as the "effective" configuration. The hourly capacities and annual service volume of the runway configuration are as follows:

	Hourly Capacity (operations per hour) VFR	Hourly Capacity (operations per hour) IFR	Annual Service Volume (operations per year)
Configuration 12	111	70	300,000

It is noted that because of the assumptions concerning runway utilization made in the preparation of Figure A1-1, the capacity of Configuration 12 in this example is the same as the capacity of Configuration 3.

4. PROCEDURES FOR ESTIMATING ANNUAL DELAY TO AIRCRAFT ON RUNWAYS. The following procedure is used in determining an approximate estimate of annual delay to aircraft on a runway configuration:

a. Estimate the annual demand on the runway configuration

b. Determine the annual service volume of the runway configuration

c. Calculate the ratio of annual demand to annual service volume for the runway configuration

d. Estimate the average annual delay per aircraft on the runway configuration from Figure A1-2.

e. Compute the total annual delay, DTA, to aircraft on the runway configuration by the following formula:

DTA = AD x DAA

where,

AD = annual demand on the runway configuration

DAA = average annual delay per aircraft

Example 4, Annual Delay to Aircraft

Determine the annual delay to aircraft on a runway configuration serving an annual demand of 300,000 operations per year which are primarily air carrier. Assume the annual service volume of the runway configuration is 375,000 operations per year.

The ratio of annual demand to annual service volume is 300,000 ÷ 375,000 = 0.8. As noted in Paragraph 2.h., on page 4, the upper portion of the shaded band on Figure A1-2 is representative of airports primarily serving air carrier operations. Consequently, from Figure A1-2, the average annual delay per aircraft may range from 0.95 minutes to 1.45 minutes (as illustrated in the reproduction of Figure A1-2 on the following page).

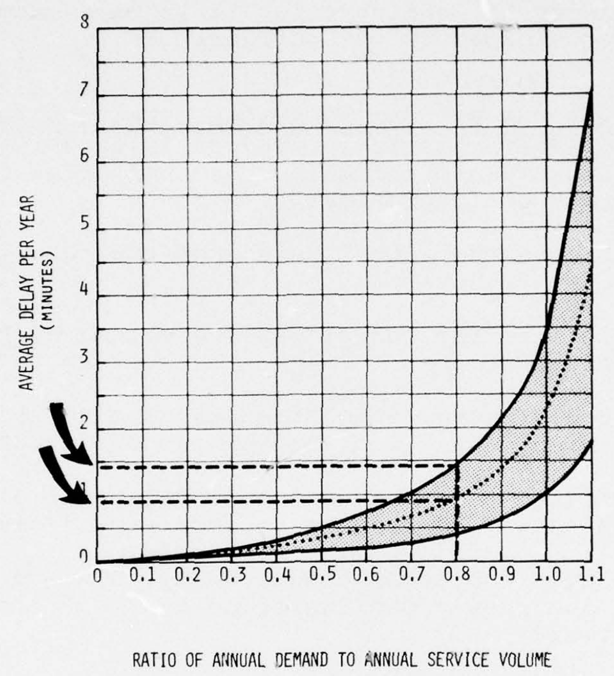


FIGURE A1-2 PRELIMINARY ANALYSIS OF AVERAGE AIRCRAFT DELAY IN A YEAR

Therefore, the total annual delay to aircraft may range from 300,000 x 0.95 = 285,000 minutes to 300,000 x 1.45 = 435,000 minutes.

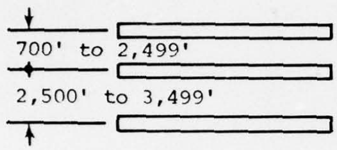
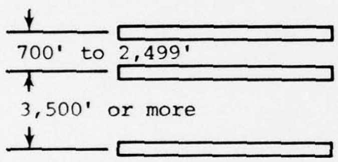
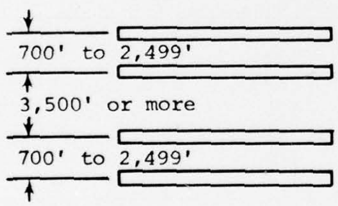
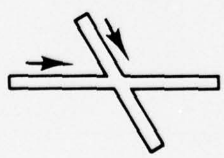
Example 5, Annual Delay to Aircraft

Determine the annual delay to aircraft on a runway configuration serving an annual demand of 450,000 operations per year which are primarily general aviation. Assume the annual service volume of the runway configuration is 500,000 operations per year.

The ratio of annual demand to annual service volume is 450,000 ÷ 500,000 = 0.9. As noted in Paragraph 2.h on page 4 of this appendix, airports serving primarily general aviation operations may typically fall anywhere within the entire shaded band on Figure A1-2. Consequently, from Figure A1-2, the average annual delay per aircraft may range from 0.6 minutes to 2.2 minutes. The average annual delay per aircraft using the dotted curve on Figure A1-2 is 1.4 minutes. Therefore, the total annual delay to aircraft may range from 450,000 x 0.6 = 270,000 minutes to 450,000 x 2.2 = 990,000 minutes. The total annual delay to aircraft using the dotted curve is 450,000 x 1.4 = 630,000 minutes.

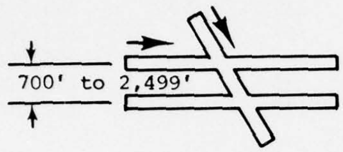
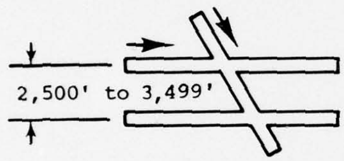
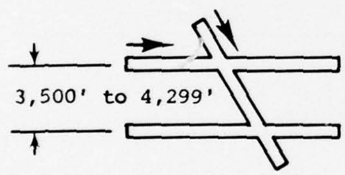
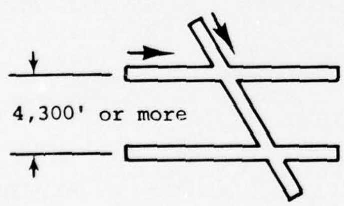
No.	Runway Configuration Diagram	Mix Index--Percent(C+3D)	Hourly Capacity (operations per hour) VFR	IFR	Annual Service Volume (operations per year)
1.		0 to 20	98	59	230,000
		21 to 50	74	57	195,000
		51 to 80	63	56	205,000
		81 to 120	55	53	210,000
		121 to 180	51	50	240,000
2.	700' to 2,499'	0 to 20	197	59	355,000
		21 to 50	145	57	275,000
		51 to 80	121	56	260,000
		81 to 120	105	59	285,000
		121 to 180	94	60	340,000
3.	2,500' to 3,499'	0 to 20	197	62	355,000
		21 to 50	149	63	285,000
		51 to 80	126	65	275,000
		81 to 120	111	70	300,000
		121 to 180	103	75	365,000
4.	3,500' to 4,299'	0 to 20	197	62	355,000
		21 to 50	149	63	285,000
		51 to 80	126	65	275,000
		81 to 120	111	70	300,000
		121 to 180	103	75	365,000
5.	4,300' or more	0 to 20	197	119	370,000
		21 to 50	149	114	320,000
		51 to 80	126	111	305,000
		81 to 120	111	105	315,000
		121 to 180	103	99	370,000
6.	700' to 2,499' / 700' to 2,499'	0 to 20	295	62	385,000
		21 to 50	213	63	305,000
		51 to 80	171	65	285,000
		81 to 120	149	70	310,000
		121 to 180	129	75	375,000

FIGURE A1-1 PRELIMINARY ANALYSIS OF CAPACITY

No.	Runway Configuration Diagram	Mix Index--Percent (C+3D)	Hourly Capacity (operations per hour) VFR	IFR	Annual Service Volume (operations per year)
7.		0 to 20	295	62	385,000
		21 to 50	219	63	310,000
		51 to 80	184	65	290,000
		81 to 120	161	70	315,000
		121 to 180	146	75	385,000
8.		0 to 20	295	119	625,000
		21 to 50	219	114	475,000
		51 to 80	184	111	455,000
		81 to 120	161	117	510,000
		121 to 180	146	120	645,000
9.		0 to 20	394	119	715,000
		21 to 50	290	114	550,000
		51 to 80	242	111	515,000
		81 to 120	210	117	565,000
		121 to 180	189	120	675,000
10.		0 to 20	98	59	230,000
		21 to 50	77	57	200,000
		51 to 80	77	56	215,000
		81 to 120	76	59	225,000
		121 to 180	72	60	265,000

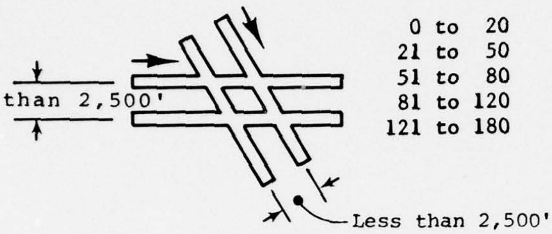
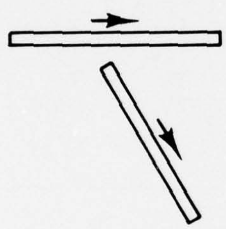
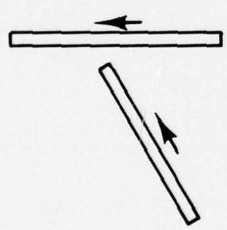
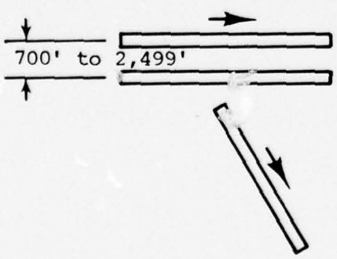
NOTE: → Denotes predominant direction of runway operation.

FIGURE A1–1 PRELIMINARY ANALYSIS OF CAPACITY (CONTINUED)

No.	Runway Configuration Diagram	Mix Index-- Percent (C+3D)	Hourly Capacity (operations per hour) VFR	IFR	Annual Service Volume (operations per year)
11.		0 to 20	197	59	355,000
		21 to 50	145	57	275,000
		51 to 80	121	56	260,000
		81 to 120	105	59	285,000
		121 to 180	94	60	340,000
12.		0 to 20	197	62	355,000
		21 to 50	149	63	285,000
		51 to 80	126	65	275,000
		81 to 120	111	70	300,000
		121 to 180	103	75	365,000
13.		0 to 20	197	62	355,000
		21 to 50	149	63	285,000
		51 to 80	126	65	275,000
		81 to 120	111	70	300,000
		121 to 180	103	75	365,000
14.		0 to 20	197	119	370,000
		21 to 50	149	114	320,000
		51 to 80	126	111	305,000
		81 to 120	111	105	315,000
		121 to 180	103	99	370,000

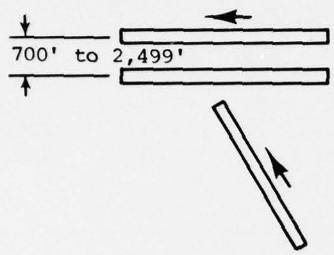
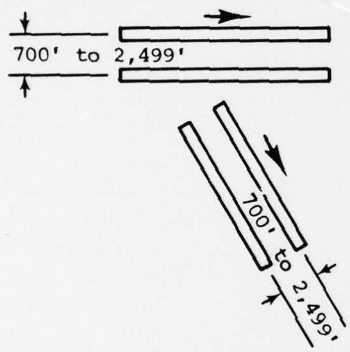
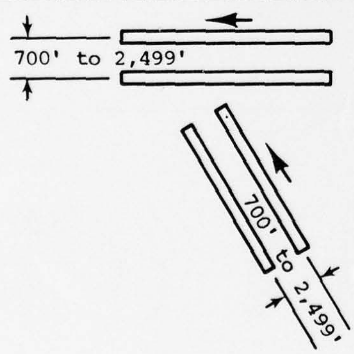
NOTE: → Denotes predominant direction of runway operation.

FIGURE A1–1 PRELIMINARY ANALYSIS OF CAPACITY (CONTINUED)

No.	Runway Configuration Diagram	Mix Index-- Percent(C+3D)	Hourly Capacity (operations per hour) VFR	IFR	Annual Service Volume (operations per year)
15.		0 to 20	197	59	355,000
		21 to 50	147	57	275,000
		51 to 80	145	56	270,000
		81 to 120	138	59	295,000
		121 to 180	125	60	350,000
16.		0 to 20	150	59	270,000
		21 to 50	108	57	225,000
		51 to 80	85	56	220,000
		81 to 120	77	59	225,000
		121 to 180	73	60	265,000
17.		0 to 20	132	59	260,000
		21 to 50	99	57	220,000
		51 to 80	82	56	215,000
		81 to 120	77	59	225,000
		121 to 180	73	60	265,000
18.		0 to 20	295	59	385,000
		21 to 50	210	57	305,000
		51 to 80	164	56	275,000
		81 to 120	146	59	300,000
		121 to 180	129	60	355,000

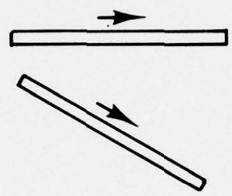
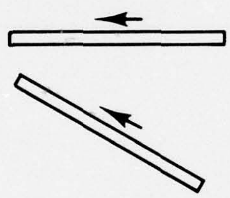
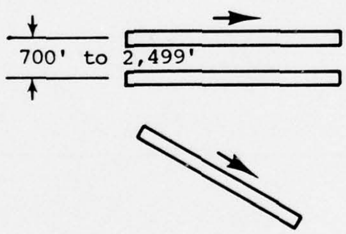
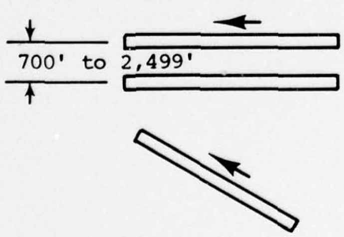
NOTE: → Denotes predominant direction of runway operation.

FIGURE A1–1 PRELIMINARY ANALYSIS OF CAPACITY (CONTINUED)

No.	Runway Configuration Diagram	Mix Index--Percent(C+3D)	Hourly Capacity (operations per hour) VFR	IFR	Annual Service Volume (operations per year)
19.		0 to 20	197	59	355,000
		21 to 50	145	57	275,000
		51 to 80	121	56	260,000
		81 to 120	105	59	285,000
		121 to 180	94	60	340,000
20.		0 to 20	301	59	385,000
		21 to 50	210	57	305,000
		51 to 80	164	56	275,000
		81 to 120	146	59	300,000
		121 to 180	129	60	355,000
21.		0 to 20	264	59	375,000
		21 to 50	193	57	295,000
		51 to 80	158	56	275,000
		81 to 120	146	59	300,000
		121 to 180	129	60	355,000

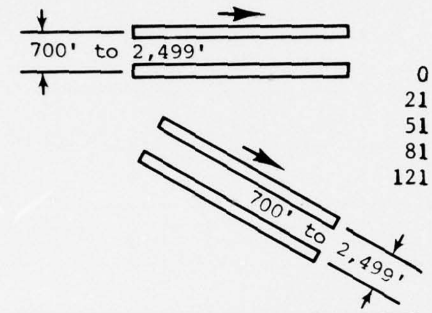
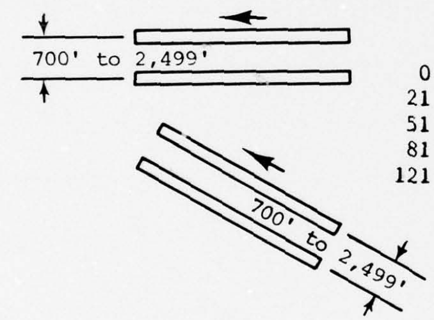
NOTE: → Denotes predominant direction of runway operation.

FIGURE A1–1 PRELIMINARY ANALYSIS OF CAPACITY (CONTINUED)

No.	Runway Configuration Diagram	Mix Index--Percent (C+3D)	Hourly Capacity (operations per hour) VFR	IFR	Annual Service Volume (operations per year)
22.		0 to 20	150	59	270,000
		21 to 50	108	57	225,000
		51 to 80	85	56	220,000
		81 to 120	77	59	225,000
		121 to 180	73	60	265,000
23.		0 to 20	132	59	260,000
		21 to 50	99	57	220,000
		51 to 80	82	56	215,000
		81 to 120	77	59	225,000
		121 to 180	73	60	265,000
24.		0 to 20	295	59	385,000
		21 to 50	210	57	305,000
		51 to 80	164	56	275,000
		81 to 120	146	59	300,000
		121 to 180	129	60	355,000
25.		0 to 20	197	59	355,000
		21 to 50	145	57	275,000
		51 to 80	121	56	260,000
		81 to 120	105	59	285,000
		121 to 180	96	60	340,000

NOTE: → Denotes predominant direction of runway operation.

FIGURE A1–1 PRELIMINARY ANALYSIS OF CAPACITY (CONTINUED)

No.	Runway Configuration Diagram	Mix Index-- Percent(C+3D)	Hourly Capacity (operations per hour) VFR	IFR	Annual Service Volume (operations per year)
26.		0 to 20	301	59	385,000
		21 to 50	210	57	305,000
		51 to 80	164	56	275,000
		81 to 120	146	59	300,000
		121 to 180	129	60	355,000
27.		0 to 20	264	59	375,000
		21 to 50	193	57	295,000
		51 to 80	158	56	275,000
		81 to 120	146	59	300,000
		121 to 180	129	60	355,000

NOTE: → Denotes predominant direction of runway operation.

SPECIAL NOTE:

(1) The configurations shown above do not include layouts with more than two runway orientations. Therefore, for those airports with runway configurations involving three or more orientations, it is necessary to identify the runways in the <u>two</u> orientations used most frequently.

(2) Missed approach protection is assumed for converging operations in IFR conditions.

(3) Multiple arrival streams are only permitted on parallel runways.

FIGURE A1–1 PRELIMINARY ANALYSIS OF CAPACITY (CONTINUED)

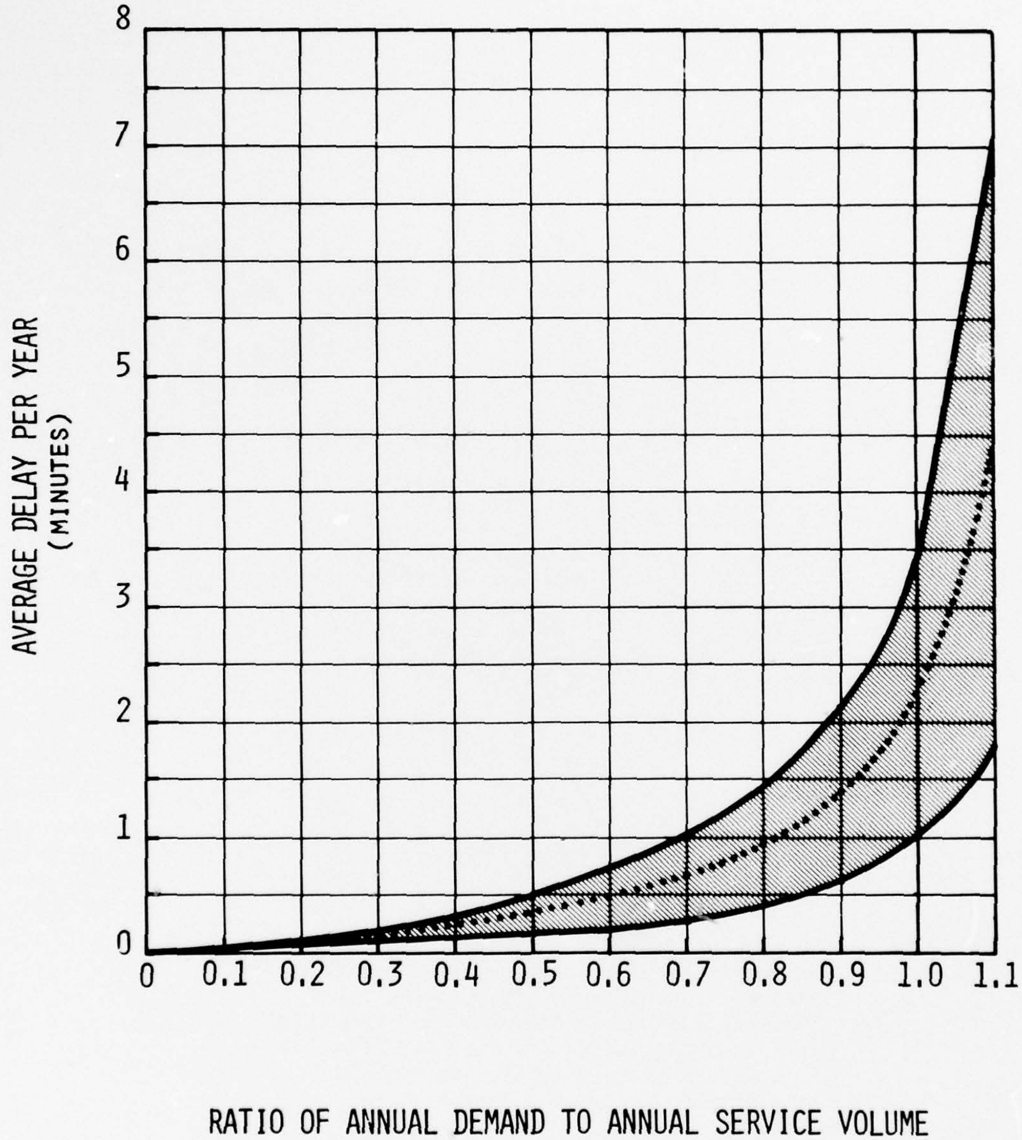


FIGURE A1-2 PRELIMINARY ANALYSIS OF AVERAGE AIRCRAFT DELAY IN A YEAR

APPENDIX 2. EFFECT OF CEILING AND VISIBILITY ON RUNWAY CAPACITY

1. GENERAL. For purposes of determining the hourly capacity of runways in Chapter 2, the terms VFR and IFR are used as measures relating to ceiling and visibility. These terms are defined in Chapter 1. Although appropriate for the vast majority of handbook applications, the use of VFR and IFR is a simplification of real-world operating procedures and practices. In reality, the effect of ceiling and visibility on capacity is complex and varies from airport to airport.

   In the planning of high-activity airports, the occurrence of poor visibility and ceiling conditions (i.e., poor visibility/ceiling or "PVC") may be significant enough to warrant further analysis of runway capacity during IFR conditions.

   This appendix presents a procedure to estimate the hourly capacities of a single runway and certain two parallel and intersecting runway uses during PVC conditions. For purposes of this appendix, PVC conditions are defined as occurring when ceiling is below about 500 feet and/or the visibility is less than about one mile. Thus, PVC conditions are a subset of IFR conditions. Detailed assumptions used in the preparation of this appendix are set forth in a companion report.[2]

2. PROCEDURE FOR DETERMINING HOURLY CAPACITY OF RUNWAYS DURING POOR VISIBILITY AND CEILING (PVC). The following procedure is used in the determination of capacity using Figures A2-1 through A2-15 located at the end of this appendix.

   For each runway use under consideration:

   a. Identify the runway use from Figure A2-1. From this figure, find the appropriate figure for determining capacity.

   b. Determine the mix index.

c. Determine the percent arrivals.

d. Estimate the hourly capacity from the appropriate figure.[a]

Example 1, Hourly Capacity, Single Runway, PVC

Determine the hourly capacity for a single runway in PVC under the following conditions:

Aircraft Mix: 5% A, 10% B, 60% C, and 25% D

Percent Arrivals: 40%

From Figure A2-1, select Runway Use Diagram No. 1. The corresponding figure number for estimating capacity in PVC is Figure A2-2, (as illustrated in the reproduction of Figure A2-1, below).

RUNWAY USE DIAGRAM	DIAG. NO.	RUNWAY SPACING IN FEET (s)	FIGURE NO. FOR CAPACITY IN PVC
	1	N.A.	A2-2
	2a	700 TO 2499	A2-3
	2b	2500 TO 3499*	A2-3
	2c	3500* TO 4299	A2-4
		OR MORE	A2-4

The mix index for the assumed aircraft mix is Percent (C+3D) = 60 + 3 x 25 = 135. Therefore, from Figure A2-2, the hourly capacity of the runway is 47 operations per hour (as illustrated in the reproduction of Figure A2-2, on the following page).

a. For purposes of this appendix, it is assumed that sufficient exit taxiways exist to permit the capacity of the runways to be fully realized. An approximate determination of the effect of the number and location of exit taxiways on runway capacity in PVC may be made using the exit factor (E) portion of the corresponding figure for IFR conditions in Chapter 2.

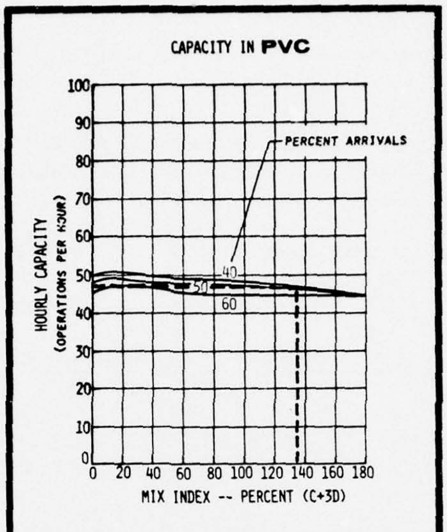
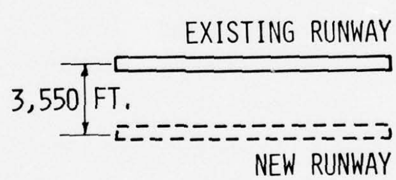


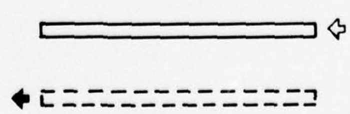
FIGURE A2-2 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 1

Example 2, Hourly Capacity, Parallel Runways, PVC

Assume that a new parallel runway is added to the airport in Example 1. The spacing between the two runways is 3,550 feet as illustrated below.



Assume the following runway use:



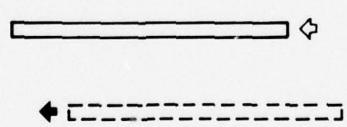
From Figure A2-1, select Runway Use Diagram No. 2c. The corresponding figure number for estimating capacity in PVC is Figure A2-4.

As in Example 1, the mix index is Percent (C+3D) = 60 + 3 x 25 = 135. Therefore, from Figure A2-4, the hourly capacity of the runways is 73 operations per hour.

<u>Example 3, Hourly Capacity, Parallel Runways with Threshold Stagger, PVC</u>

Assume an airfield identical to that in Example 2 except that the new runway is shifted 500 feet to the east, as illustrated below.

Assume the same runway use as in Example 2.



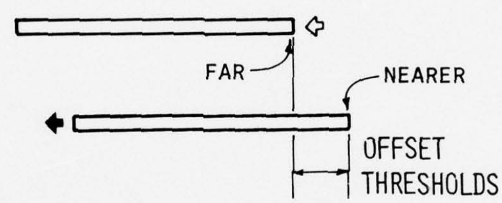
Determine the hourly capacity of the runways in PVC under the following conditions:

Aircraft Mix: 5% A, 10% B, 60% C, and 25% D
Percent Arrivals: 40%

Because the runway thresholds are staggered (offset) by 500 feet, it is necessary to determine the "effective" spacing or lateral separation between the runways before the appropriate runway use diagram can be identified.

As indicated in the footnote(*) to Figure A2-1, the "effective" spacing should be increased by 100 feet for every 500 feet of threshold stagger when an arriving aircraft is approaching the nearer runway. Conversely, the "effective" spacing should be decreased by 100 feet for every 500 feet of threshold stagger when an arriving aircraft is approaching the far runway.

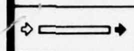
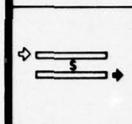
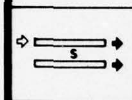
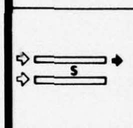
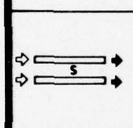
In this example, the nearer and far runway are illustrated below:

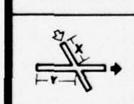
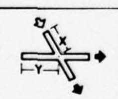


Therefore, the "effective" lateral separation is 3,550 feet minus 100 feet, or 3,450 feet.

For the above runway use, from Figure A2-1, Runway Use Diagram No. 2b is selected. The corresponding figure number in PVC is Figure A2-3.

As in Examples 1 and 2, the mix index is Percent (C+3D) = 60 + 3 x 25 = 135. Therefore, from Figure A2-3, the hourly capacity of the runway is 68 operations per hour.

RUNWAY USE DIAGRAM	DIAG. NO.	RUNWAY SPACING IN FEET ($)	FIGURE NO. FOR CAPACITY IN PVC
	1	N.A.	A2-2
	2a	700 TO 2499	A2-3
	2b	2500 TO 3499*	A2-3
	2c	3500* TO 4299	A2-4
	2d	4300 OR MORE	A2-4
	3	700 TO 2499	A2-3
	4	2500 TO 3499*	A2-5
	5	3500* OR MORE	A2-6
	6	700 TO 2499	A2-3
	7a	2500 TO 3499	A2-7
	7b	3500 TO 4299	A2-8
	8	4300 OR MORE	A2-9
	9	700 TO 2499	A2-3
	10	2500 TO 3499	A2-10
	11	3500 TO 4299	A2-11
	12	4300 OR MORE	A2-12

RUNWAY USE DIAGRAM	DIAG. NO.	INTERSECTION DISTANCE (FEET) X	Y	FIGURE NO. FOR CAPACITY IN PVC
	43a	0 TO 1999	0 TO 8000	A2-13
	43b	2000 TO 4999	0 TO 8000	A2-14
	43c	5000 TO 8000	0 TO 8000	A2-15
	49a	0 TO 1999	0 TO 8000	A2-13
	49b	2000 TO 4999	0 TO 8000	A2-14
	49c	5000 TO 8000	0 TO 8000	A2-15

LEGEND:

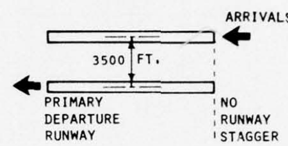
- ⇨ Indicates that an arrival (or landing) can occur on the runway indicated.
- ➧ Indicates that a departure (or takeoff) can occur on the runway indicated.

The lack of a symbol means that aircraft operations will not occur on the runway indicated.

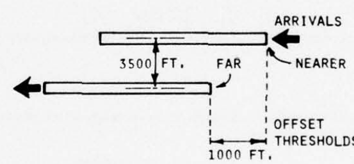
- $ Indicates a variable runway spacing.
- X,Y Indicates intersection distances.
- N.A. Not applicable.

*THRESHOLD STAGGER: WHEN THRESHOLDS ARE STAGGERED AND THE ARRIVING AIRCRAFT IS APPROACHING THE NEARER RUNWAY, EFFECTIVE SPACING IS INCREASED BY 100 FEET FOR EVERY 500 FEET OF STAGGER.

THERE IS AN EQUIVALENT NEGATIVE CORRECTION WHEN ARRIVAL AIRCRAFT ARE APPROACHING THE FAR RUNWAY.



EFFECTIVE SPACING = 3500 FT.

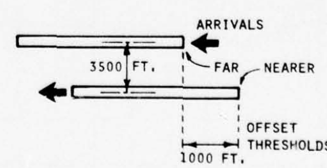


EFFECTIVE SPACING = 3700 FT.

$\frac{1000}{500} = 2 \times 100 = +200$ FT.

POSITIVE CORRECTION

(+100 FT. SPACING FOR EVERY 500 FT. OF STAGGER)



EFFECTIVE SPACING = 3300 FT.

$\frac{-1000}{500} = -2 \times 100 = -200$ FT.

NEGATIVE CORRECTION

(- 100 FT. SPACING FOR EVERY 500 FT. OF STAGGER)

FIGURE A2–1 RUNWAY USES FOR PVC CONDITIONS

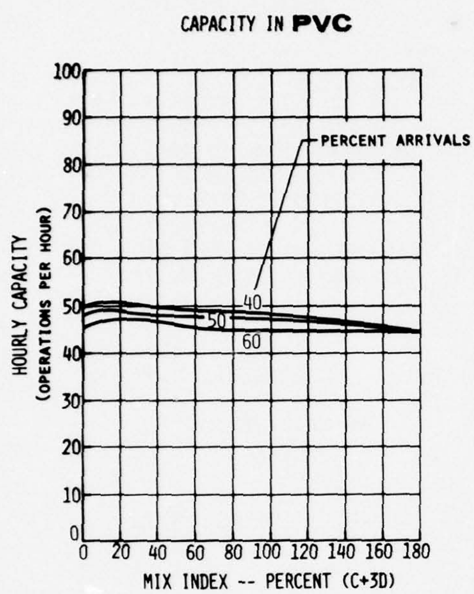


FIGURE A2-2 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 1

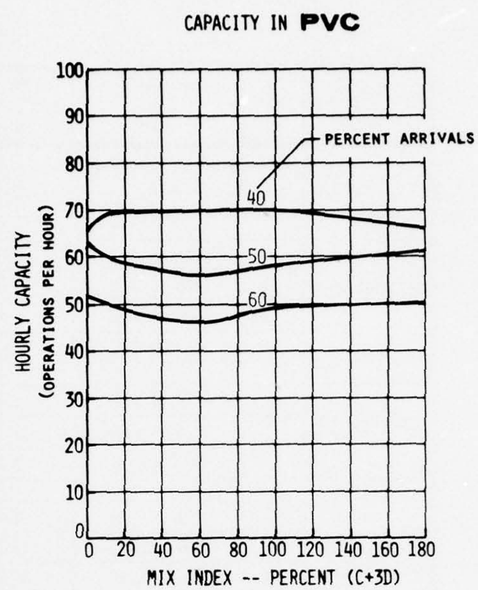


FIGURE A2-3 HOURLY CAPACITY OF RUNWAY USE DIAG. NOS. 2a, 2b, 3, 6, 9

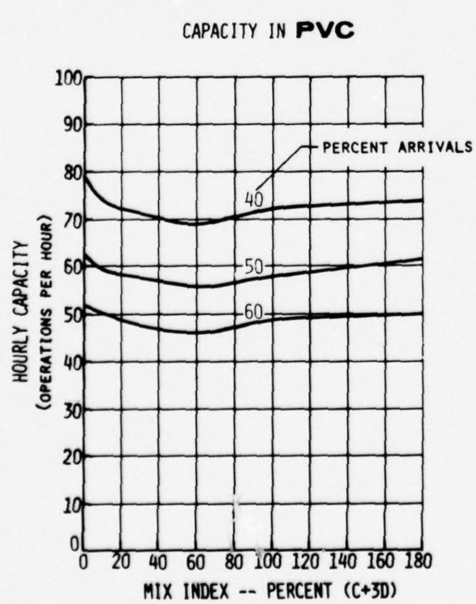


FIGURE A2-4 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 2c, 2d

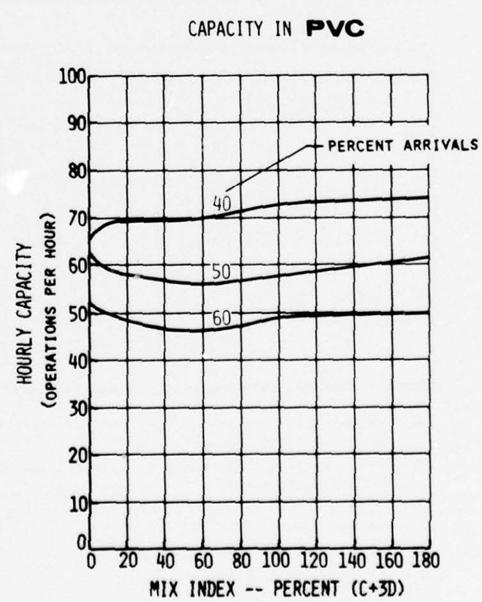


FIGURE A2-5 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 4

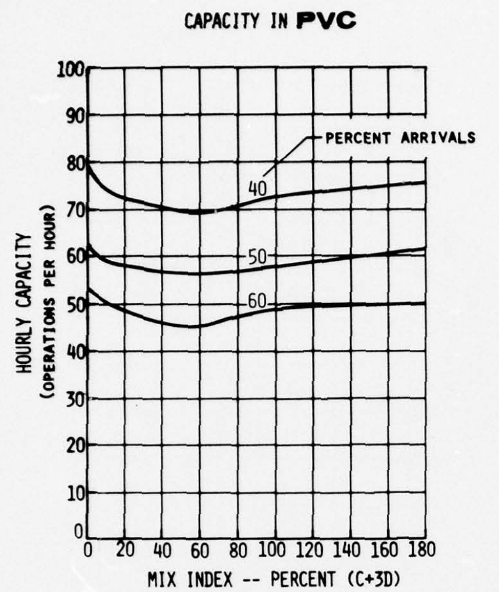


FIGURE A2-6 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 5

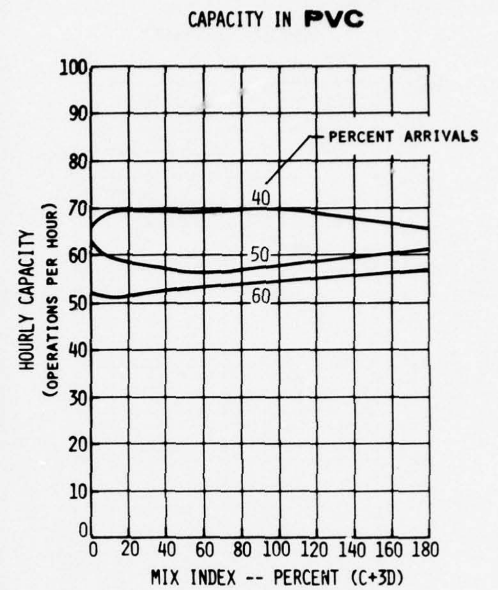


FIGURE A2-7 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 7a

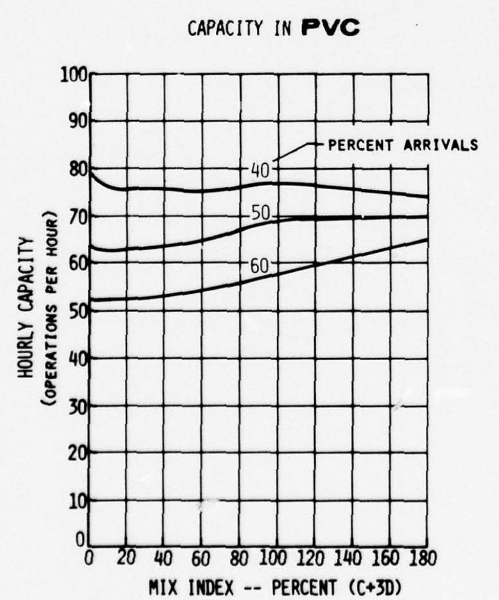


FIGURE A2-8 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 7b

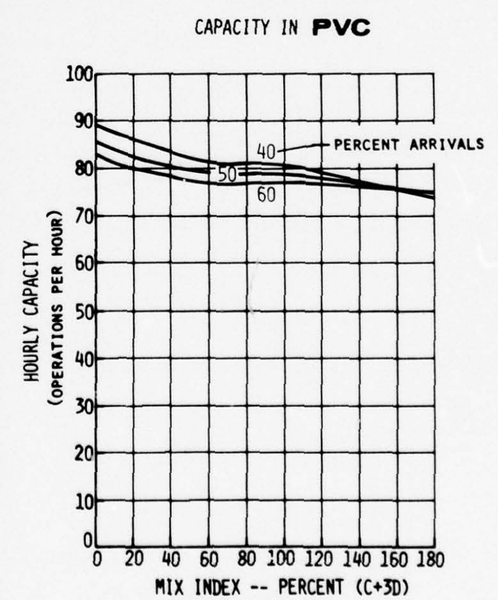


FIGURE A2-9 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 8

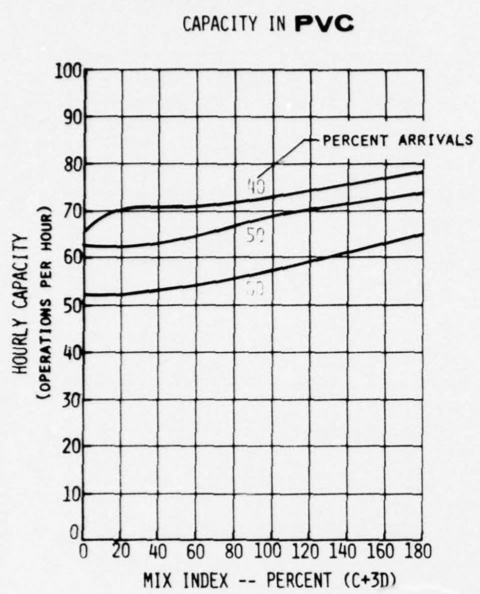


FIGURE A2–10 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 10

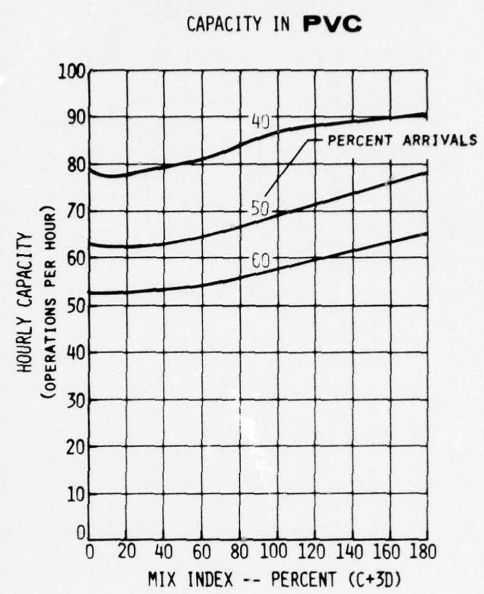


FIGURE A2–11 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 11

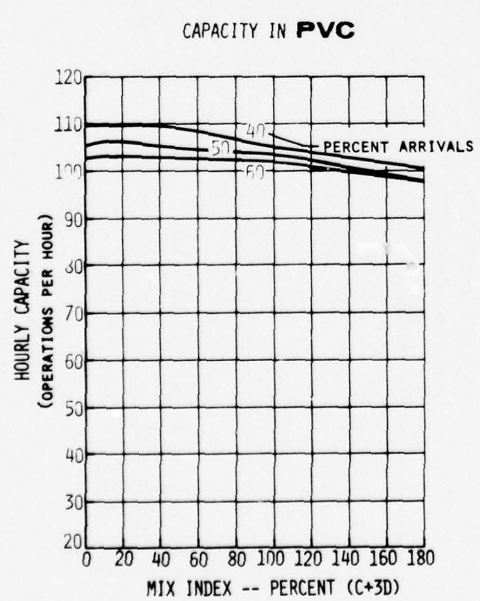


FIGURE A2–12 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 12

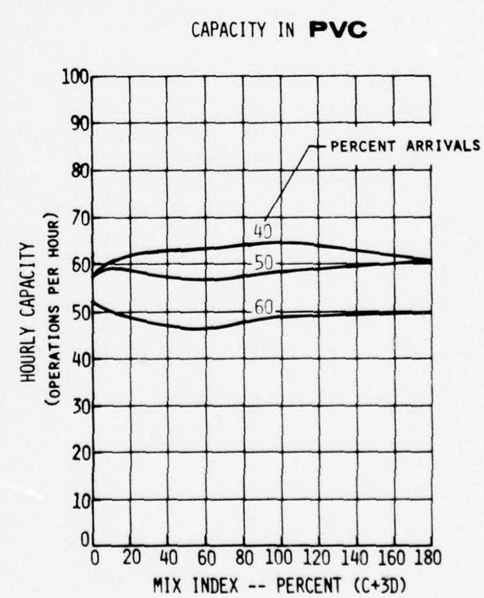


FIGURE A2-13 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 43a, 49a

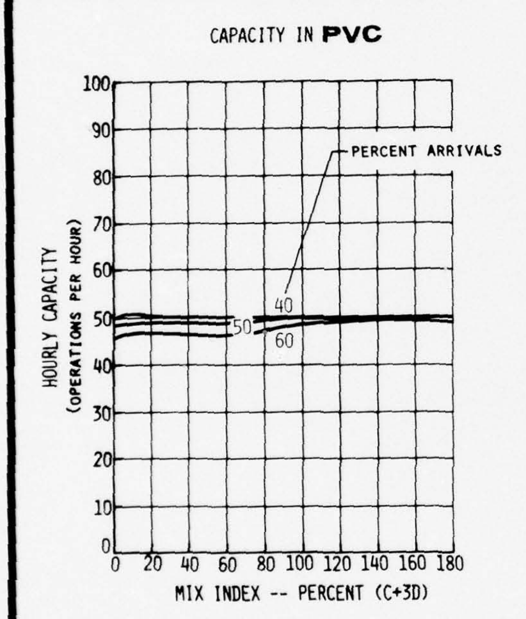


FIGURE A2–14 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 43b, 49b

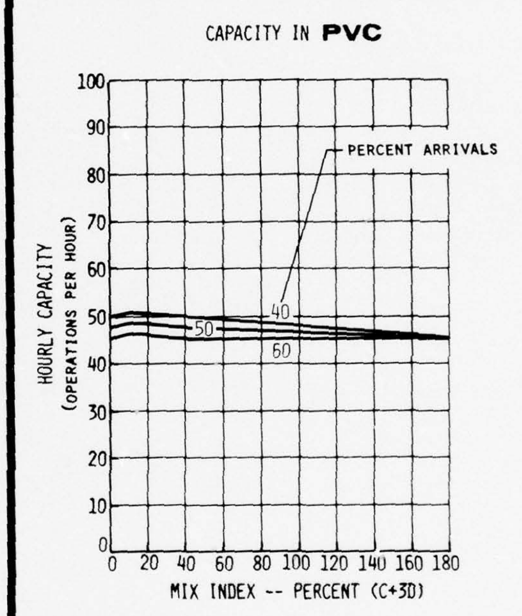


FIGURE A2–15 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 43c, 49c

APPENDIX 3. EFFECT OF NAVIGATIONAL AIDS ON RUNWAY CAPACITY

1. GENERAL. For purposes of determining the hourly capacity of runways in Chapters 2, 3, and 4, it is assumed that operations are conducted in a radar environment and that arrivals operate on at least one runway equipped with an ILS (i.e., an ILS approach).

This appendix presents a procedure to estimate the hourly capacities of a single runway and certain two parallel and intersecting runway uses in IFR conditions without a radar environment and/or an ILS. For purposes of this appendix, if an ILS approach is not available, it is assumed that either a straight-in or circling nonprecision approach[a] exists. In addition, for purposes of this appendix, it is assumed that one-half (50%) of the demand for the use of the runways is by arriving aircraft. Thus, the number of arriving and departing aircraft in a specified period of time is equal.

2. PROCEDURE FOR DETERMINING HOURLY CAPACITY OF RUNWAYS WITHOUT RADAR ENVIRONMENT AND/OR ILS. The following procedure is used in the determination of capacity in IFR conditions using Figures A3-1 through A3-3 located at the end of this appendix.

For each runway use under consideration:

a. Identify the runway use from Figure A3-1. From this figure, find the appropriate figure for determining capacity.

b. Determine the availability of navigational aids (i.e., radar or nonradar environment; ILS approach or type of nonprecision approach).

c. Determine the mix index.

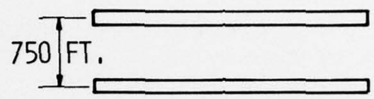
d. Determine the hourly capacity from the appropriate figure.

---

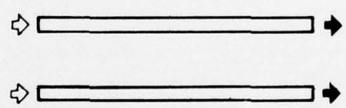
a. Reference: "United States Standard for Terminal Instrument Procedures (TERPS)," Second Edition, with changes.

Example 1, Hourly Capacity, Parallel Runways, IFR (with Radar Environment and a Circling Approach)

Consider a parallel runway configuration as illustrated below.



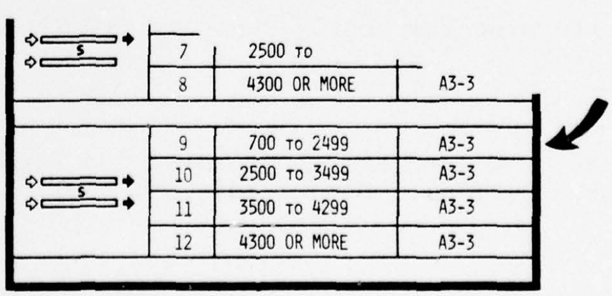
The following runway use is in effect:



Determine the hourly capacity in IFR of the parallel runways under the following conditions:

> Aircraft Mix: 35% A, 30% B, 30% C, 5% D
> Available Navigational Aids: Radar environment, circling approach

From Figure A3-1, select Runway Use Diagram No. 9. The corresponding figure number for estimating capacity is Figure A3-3 (as illustrated in the reproduction of Figure A3-1, below).



	7	2500 TO	
	8	4300 OR MORE	A3-3
	9	700 TO 2499	A3-3
	10	2500 TO 3499	A3-3
	11	3500 TO 4299	A3-3
	12	4300 OR MORE	A3-3

The mix index for the assumed aircraft mix is Percent (C+3D) = 30 + 3 x 5 = 45. Therefore, from Figure A3-3A (i.e., radar environment), the hourly capacity of the runway = 38 operations per hour (as illustrated in the reproduction of Figure A3-3A below).

FIGURE A3–3A HOURLY CAPACITY IN RADAR ENVIRONMENT

FIGU

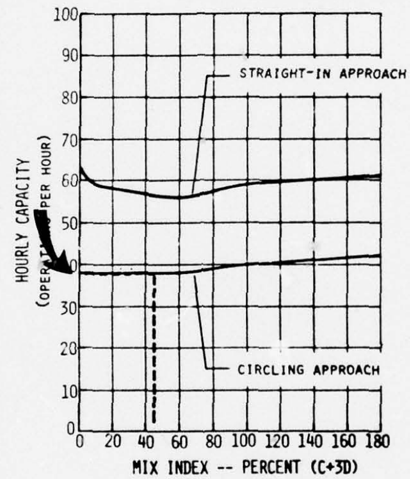
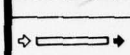
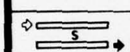
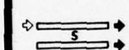
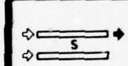
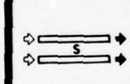
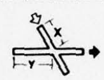
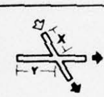


FIGURE A3–3 HOURLY CAPACITY OF R NOS. 2, 3, 4, 5, 6, 7, 8, 9,

RUNWAY USE DIAGRAM	DIAG. NO.	RUNWAY SPACING IN FEET (s)	FIGURE NO. FOR CAPACITY
	1	N.A.	A3-2
	2	700 OR MORE	A3-3
	3	700 TO 2499	A3-3
	4	2500 TO 3499	A3-3
	5	3500 OR MORE	A3-3
	6	700 TO 2499	A3-3
	7	2500 TO 4299	A3-3
	8	4300 OR MORE	A3-3
	9	700 TO 2499	A3-3
	10	2500 TO 3499	A3-3
	11	3500 TO 4299	A3-3
	12	4300 OR MORE	A3-3

RUNWAY USE DIAGRAM	DIAG. NO.	INTERSECTION DISTANCE (FEET) X	Y	FIGURE NO. FOR CAPACITY
	43	0 TO 1999	< 4000	A3-2
	44	2000 TO 4999	< 4000	A3-2
	45	5000 TO 8000	< 4000	A3-2
	46	0 TO 1999	≥ 4000	A3-2
	47	2000 TO 4999	≥ 4000	A3-2
	48	5000 TO 8000	≥ 4000	A3-2
	49	0 TO 1999	< 4000	A3-2
	50	2000 TO 4999	< 4000	A3-2
	51	5000 TO 8000	< 4000	A3-2
	52	0 TO 1999	≥ 4000	A3-2
	53	2000 TO 4999	≥ 4000	A3-2
	54	5000 TO 8000	≥ 4000	A3-2

LEGEND:

⇨ Indicates that an arrival (or landing) can occur on the runway indicated.

➡ Indicates that a departure (or takeoff) can occur on the runway indicated.

The lack of a symbol means that aircraft operations will not occur from the runway indicated.

s Indicates a variable runway spacing.

X,Y Indicates intersection distances.

N.A. Not applicable.

FIGURE A3–1 RUNWAY USES FOR VARIOUS NAVIGATIONAL AIDS CONDITIONS

FIGURE A3–2A HOURLY CAPACITY IN RADAR ENVIRONMENT

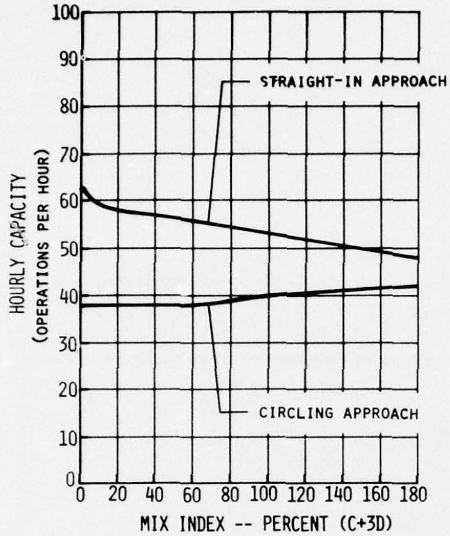


FIGURE A3–2B HOURLY CAPACITY IN NONRADAR ENVIRONMENT

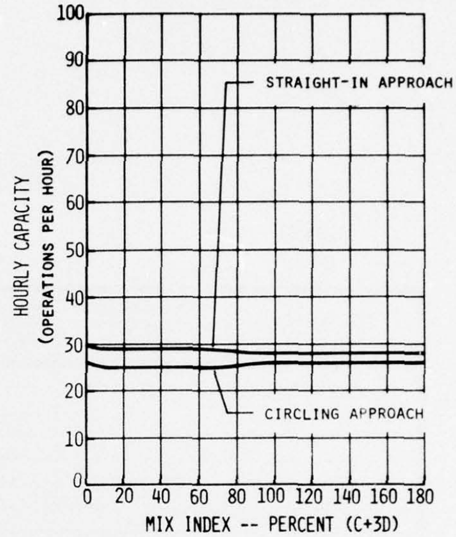


FIGURE A3–2 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 1, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54

FIGURE A3–3A HOURLY CAPACITY IN RADAR ENVIRONMENT

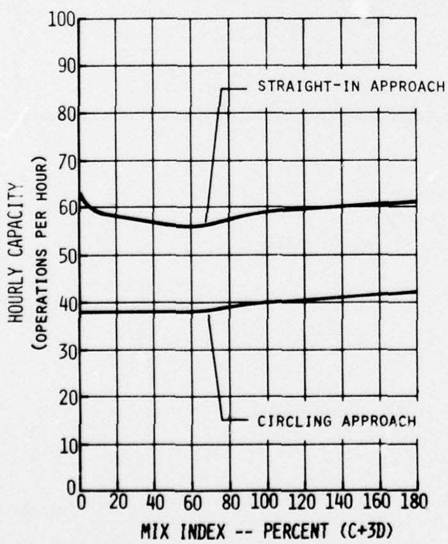


FIGURE A3–3B HOURLY CAPACITY IN NONRADAR ENVIRONMENT

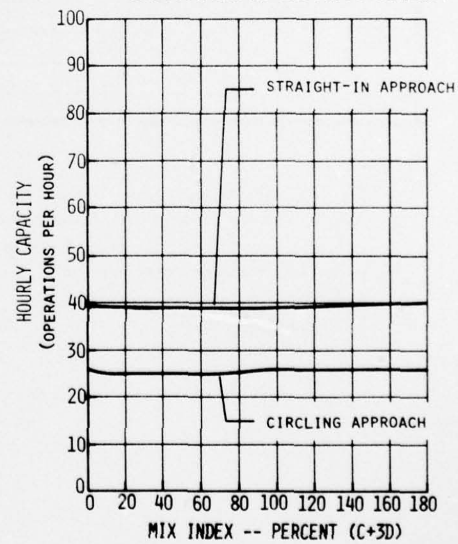


FIGURE A3–3 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

APPENDIX 4. EVALUATION OF RUNWAYS
WITHOUT MINIMUM EXIT TAXIWAYS

1. GENERAL. The procedures for determining the hourly capacity of runways in Chapters 2 and 3 are based on the assumption that at a minimum, an exit taxiway is located at both ends of each runway. However, there may be occasions when a capacity analysis is required for a runway without the minimum taxiways. Typically, such an analysis is important in connection with the staged development of a simple airport (i.e., a minimum facility consisting of a single runway without a turnaround or a parallel taxiway) into a basic airport layout (i.e., a runway with exit taxiways at each end and one exit taxiway in between). This type of analysis normally is limited to airports used solely by general aviation aircraft.

This appendix presents a simple procedure for determining runway capacity for such airports without the minimum taxiways assumed in Chapters 2 and 3. The procedure permits the determination of runway capacity for various stages of improvement of a simple airport.

Hourly runway capacities for a number of airfield configurations are presented in Figure A4-1 located at the end of this appendix. The capacities in this figure are based on a number of assumptions which are described below. If conditions at an airport differ significantly from these assumptions, the models described in Chapter 4 may be used to estimate capacity.

2. ASSUMPTIONS. The assumptions made in the preparation of Figure A4-1 are as follows:

a. Aircraft Mix. For purposes of this appendix, it is assumed that the runway is used exclusively by aircraft of Classes A and B.

b. Touch-and-Go Operations. In VFR conditions, two ranges of percent touch-and-go operations were established--from 0% to 25% touch-and-go, and from 26% to 50% touch-and-go. In IFR conditions, 0% touch-and-go operations is assumed.

c. Percent Arrivals. The capacities shown in Figure A4-1 assume that one-half (50%) of the demand for the use of the runway is by arriving aircraft. Thus, the number of arriving and departing aircraft in a specified period of time is equal.

d. Airspace and Aids to Navigation. It is assumed there is sufficient airspace to accommodate all aircraft wishing to use the runway. In addition, it is assumed that aircraft operations are conducted in a nonradar environment and that a circling approach procedure for the use of the runway is available during IFR conditions.

3. PROCEDURES FOR ESTIMATING HOURLY CAPACITY OF A RUNWAY WITHOUT MINIMUM EXIT TAXIWAYS. The following procedure should be used in determining runway capacity from Figure A4-1.

For each runway configuration under consideration:

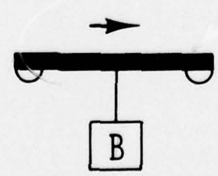
a. Identify the appropriate airfield configuration from Figure A4-1.

b. In VFR conditions, determine the percent touch-and-go operations.

c. Obtain the hourly runway capacity for both VFR and IFR conditions from Figure A4-1.

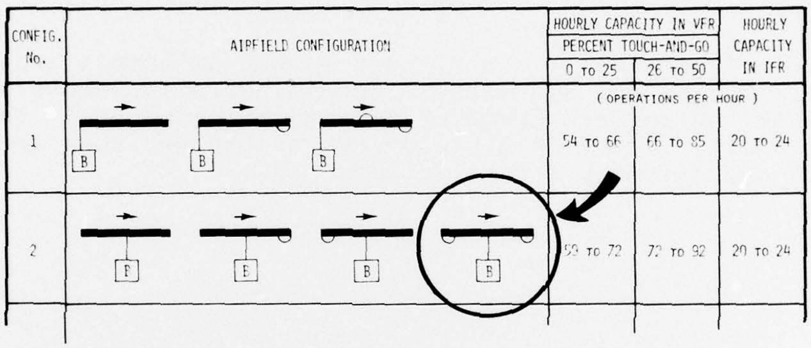
Example 1, Hourly Capacity, Single Runway with Turnaround Taxiways

Assume an airfield configuration, as illustrated below.



Determine the hourly capacity in VFR and IFR of the runway above. The aircraft mix is as follows: 90% Class A, 10% Class B, 0% Class C, and 0% Class D. There are about 15% touch-and-go operations.

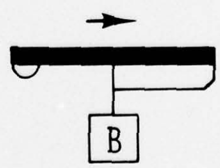
From Figure A4-1, the airfield configuration is identified as Configuration No. 2. From the figure, the hourly capacity of the runway is 59 to 72 operations per hour in VFR and 20 to 24 operations per hour in IFR (as illustrated in the reproduction of Figure A4-1 below.



CONFIG. No.	AIRFIELD CONFIGURATION	HOURLY CAPACITY IN VFR PERCENT TOUCH-AND-GO 0 TO 25	26 TO 50	HOURLY CAPACITY IN IFR
		(OPERATIONS PER HOUR)		
1	B B B	54 TO 66	66 TO 85	20 TO 24
2	B B B B	59 TO 72	72 TO 92	20 TO 24

<u>Example 2, Hourly Capacity, Single Runway with Partial Parallel Taxiway</u>

Assume that a partial parallel taxiway is added to the airport in Example 1. The airfield configuration is illustrated below.

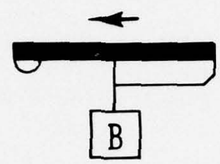


Determine the hourly capacity for the new configuration in VFR and IFR.

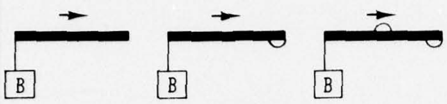
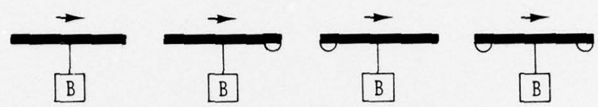
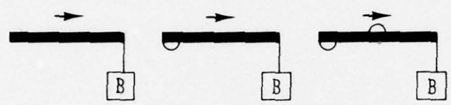
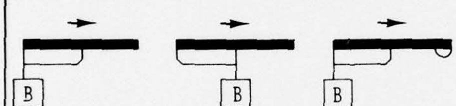
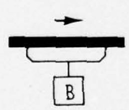
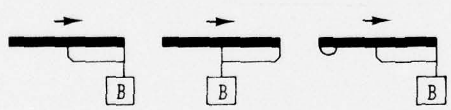
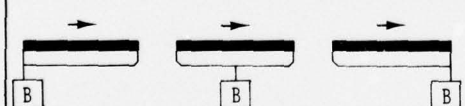
From Figure A4-1, the appropriate configuration with the partial parallel taxiway is identified as Configuration No. 6; the hourly runway capacity is 60 to 72 operations per hour in VFR and 20 to 24 operations per hour in IFR.

Example 3, Hourly Capacity, Single Runway with Partial Parallel Taxiway (Reverse Direction of Operation)

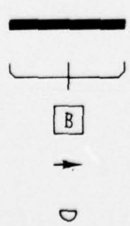
Determine the hourly capacity of the runway in Example 2, but with operations in the opposite direction, as illustrated below.



From Figure A4-1, the airport layout is identified as Configuration No. 4. (Note: the illustration above coincides with the reverse image of Configuration No. 4.) The hourly capacity in VFR is 82 to 97 operations per hour and 20 to 24 operations per hour in IFR.

CONFIG. No.	AIRFIELD CONFIGURATION	HOURLY CAPACITY IN VFR PERCENT TOUCH-AND-GO 0 TO 25	HOURLY CAPACITY IN VFR PERCENT TOUCH-AND-GO 26 TO 50	HOURLY CAPACITY IN IFR
		(OPERATIONS PER HOUR)		
1		54 TO 66	66 TO 85	20 TO 24
2		59 TO 72	72 TO 92	20 TO 24
3		40 TO 50	50 TO 67	20 TO 24
4		82 TO 97	97 TO 117	20 TO 24
5		71 TO 85	85 TO 106	20 TO 24
6		60 TO 72	72 TO 92	20 TO 24
7		SEE CHAPTER 2		

LEGEND:



RUNWAY

TAXIWAY

BASING AREA

DIRECTION OF OPERATION

TURNAROUND

FIGURE A4–1 HOURLY CAPACITY OF RUNWAY CONFIGURATION WITH LIMITED EXITS

APPENDIX 5. RUNWAY RESTRICTED USE

1. GENERAL. The procedures for determining the hourly capacity of runways in Chapters 2 and 3 are based on the assumption that all runways can be used by a majority of aircraft using an airport. At some airports, aircraft may be restricted from using a specific runway (referred to herein as "runway restricted use").

For example, such a restriction may be attributable to limited runway length or strength, insufficient lateral separation between a runway and a parallel taxiway, or aircraft noise abatement/preferential runway use procedures. Most frequently, such restrictions in the use of a runway apply to the larger, heavier aircraft using the airport.

This appendix deals with certain parallel runway uses where aircraft are restricted from using one of the runways. For purposes of this appendix, it is assumed that such restrictions apply to the larger, heavier aircraft (i.e., aircraft of Classes C and D only). Stated another way, it is assumed that one of the runways can only be used by Classes A and B aircraft (i.e., typically, only general aviation and commuter airline aircraft).

2. PROCEDURE FOR DETERMINING HOURLY CAPACITY OF RUNWAYS WITH RUNWAY RESTRICTED USE. The following procedure is used in the determination of runway capacity using Figures A5-1 through A5-10 located at the end of this appendix.

For each runway use under consideration:

a. Select the ceiling and visibility condition (VFR or IFR).

b. Identify the runway use from Figure A5-1. From this figure, find the appropriate figure for determining capacity.

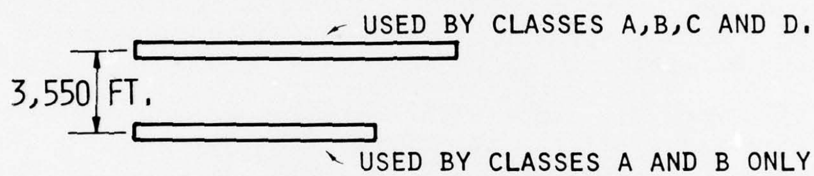
c. Determine the mix index.

d. Determine the percent arrivals.

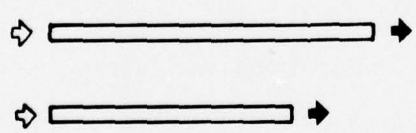
e. Estimate the hourly capacity from the appropriate figure.[a]

<u>Example 1, Hourly Capacity, Parallel Runways (with Restricted Use), VFR</u>

Consider a parallel runway configuration as illustrated below.



The following runway use is in effect:



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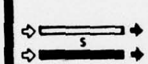
a. For purposes of this appendix, 0% touch-and-go is assumed. An approximate determination of the effect of touch-and-gos on runway capacity may be made using the touch-and-go factor (**T**) portion of the corresponding figure in Chapter 2. Similarly, it is assumed that sufficient exit taxiways exist to permit the capacity of the runways to be fully realized. An approximate determination of the effect of the number and location of exit taxiways on runway capacity may be made using the exit factor (**E**) portion of the corresponding figure in Chapter 2.

Determine the hourly capacity in VFR of the parallel runways under the following conditions:

Aircraft Mix: 10% A, 25% B, 50% C, 15%D
Percent Arrivals: 50%

From Figure A5-1, select Runway Use Diagram No. 11. The corresponding figure number for estimating capacity is Figure A5-3 (as illustrated in the reproduction of Figure A5-1, below).

RUNWAY USE DIAGRAM	DIAG. NO.	RUNWAY SPACING IN FEET (s)	FIGURE NO. FOR CAPACITY	
			VFR	IFR
	9	700 TO 2499	A5-2	A5-6
	10	2500 TO 3499	A5-3	A5-6
	11	3500 TO 4299	A5-3	A5-6
	12	4300 OR MORE	A5-3	A5-7

The mix index for the assumed aircraft mix is Percent (C+3D) = 50 + 3 x 15 = 95. Therefore, from Figure A5-3, the hourly capacity of the runways is 75 operations per hour (as illustrated in the reproduction of Figure A5-3, below).

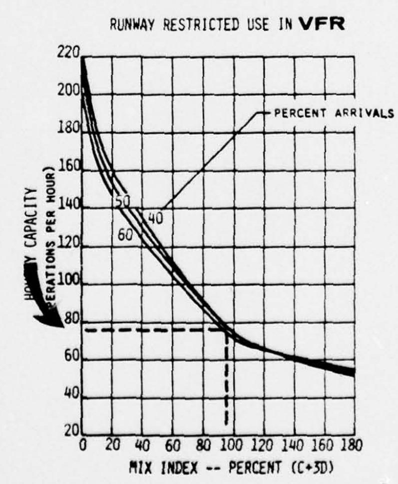


FIGURE A5-3 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 10, 11, 12

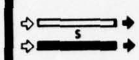
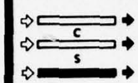
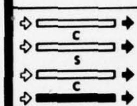
Example 2, Hourly Capacity, Parallel Runways (with Restricted Use), IFR

Determine the hourly capacity of the two runways in Example 1 in IFR under the following conditions:

Aircraft Mix: 5% A, 10% B, 60% C, 25% D
Percent Arrivals: 50%

As in Example 1, from Figure A5-1, select Runway Use Diagram No. 11. The corresponding figure number for estimating capacity is Figure A5-6.

The mix index for the assumed aircraft mix is Percent (C+3D) = 60 +3 x 25 = 135. Therefore, from Figure A5-6, the hourly capacity of the runways is 54 operations per hour.

RUNWAY USE DIAGRAM	DIAG. NO.	RUNWAY SPACING IN FEET (s)	FIGURE NO. FOR CAPACITY	
			VFR	IFR
	9	700 TO 2499	A5-2	A5-6
	10	2500 TO 3499	A5-3	A5-6
	11	3500 TO 4299	A5-3	A5-6
	12	4300 OR MORE	A5-3	A5-7
	30	2500 TO 3499	A5-4	A5-8
	31	3500 OR MORE	A5-4	A5-9
	42	3500 OR MORE	A5-5	A5-10

LEGEND:

- Runway can be used by all aircraft classes.
- Runway can be used by Class A and B aircraft only.
- Indicates that an arrival (or landing) can occur on the runway indicated.
- Indicates that a departure (or takeoff) can occur on the runway indicated.

The lack of a symbol means that aircraft operations will not occur from the runway indicated.

s Indicates a variable runway spacing.

c Indicates runway spacing category 700 to 2499 feet.

FIGURE A5–1 RUNWAY USES FOR RESTRICTED RUNWAY USE

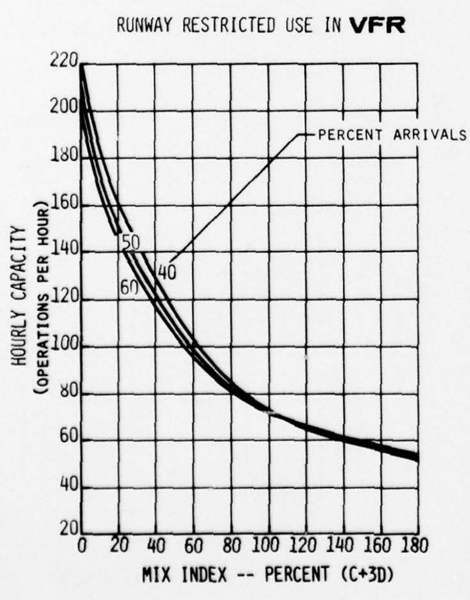


FIGURE A5–2 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 9

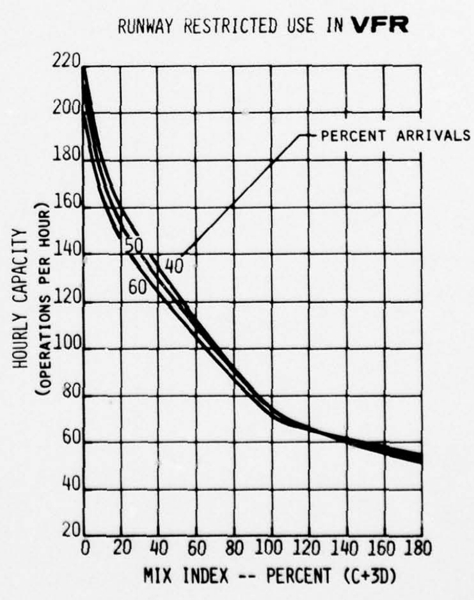


FIGURE A5–3 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 10, 11, 12

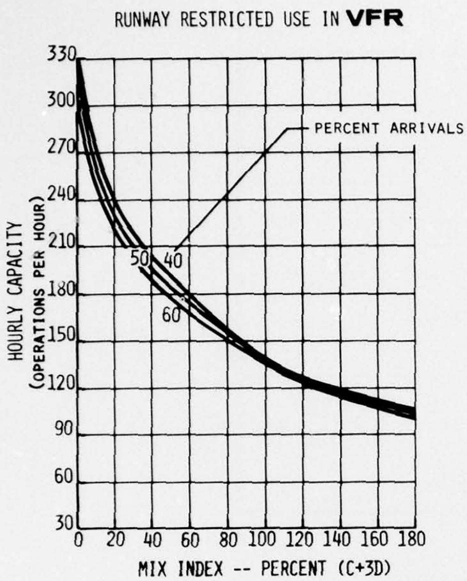


FIGURE A5–4 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NOS. 30, 31

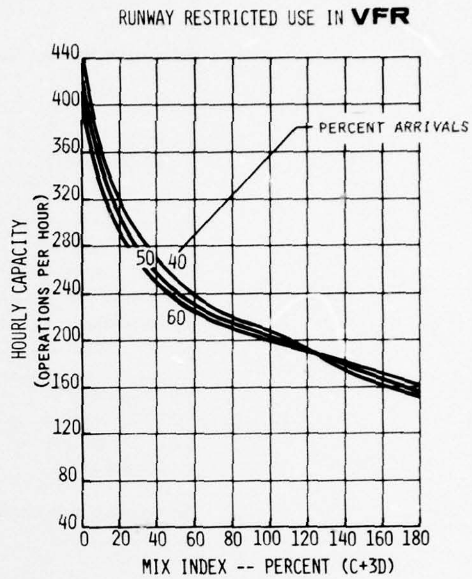


FIGURE A5–5 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 42

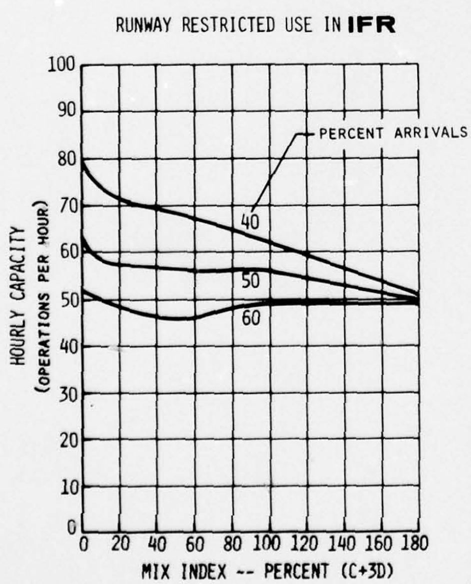


FIGURE A5–6 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NO. 9, 10, 11

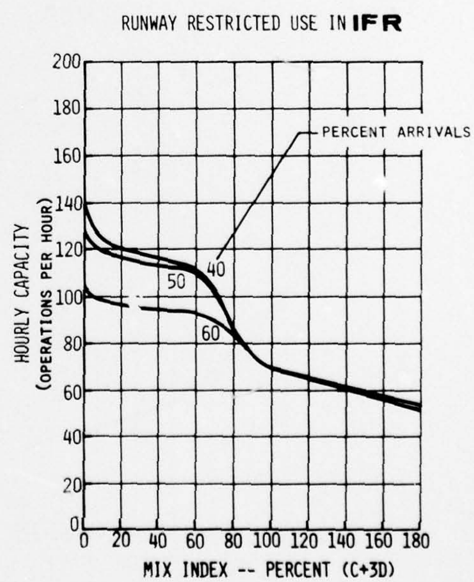


FIGURE A5–7 HOURLY CAPACITY OF RUNWAY USE DIAGRAMS NO. 12

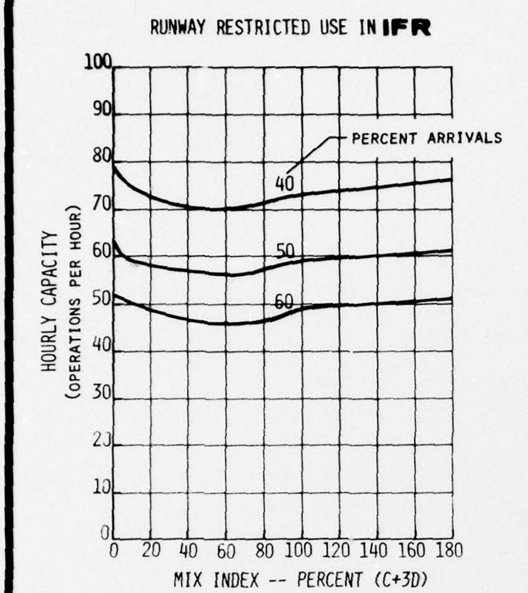


FIGURE A5-8 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 30

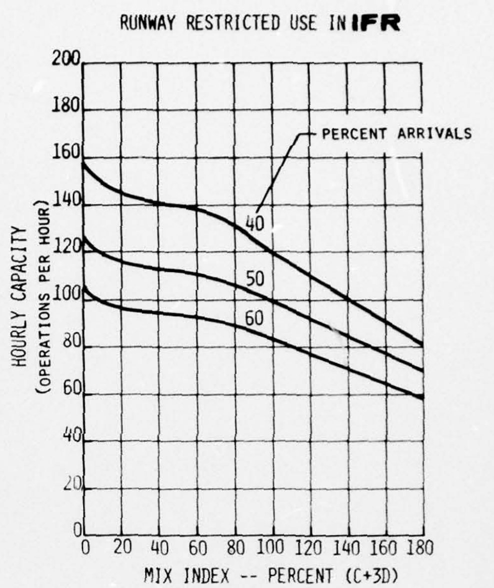


FIGURE A5-9 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 31

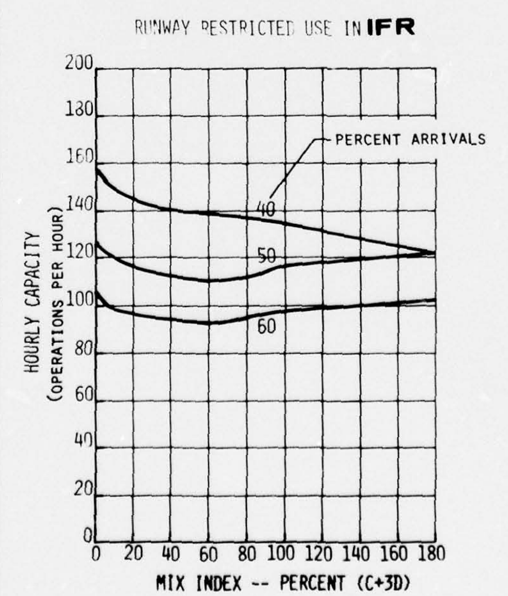


FIGURE A5-10 HOURLY CAPACITY OF RUNWAY USE DIAGRAM NO. 42